

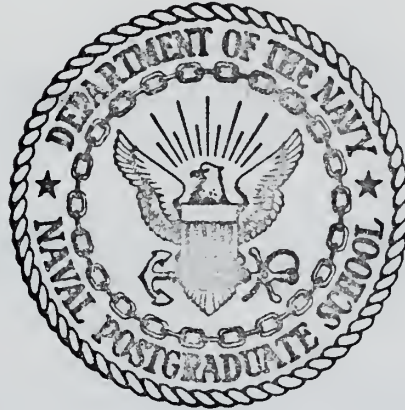
DESCRIPTION AND FORTRAN SIMULATION OF
MK 86 AA BALLISTICS

Delbert Ray Kidd

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THESIS

DESCRIPTION AND FORTRAN SIMULATION
OF
MK 86 AA BALLISTICS

by

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Thesis Advisor:

J. R. Ward

June 1973

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Description and FORTRAN
Simulation of MK 86 AA
Ballistics

by

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Lieutenant, United States Navy
B.S., University of New Mexico, 1965

Submitted in partial fulfillment of the
requirements for the degree of

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from the
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ABSTRACT

The GFCS MK86 solves the ballistics problem for the 5"/54 gun iteratively utilizing table look-ups. Each ballistics parameter table is sub-divided two-dimensionally, corresponding to selected elevation and slant range intervals. The final value for each parameter is found by interpolating between parameter values evaluated at elevation angles which bracket the actual elevation angle.

This thesis describes the method of determining the ballistics solution for AA cartesian ballistics. A description of the ballistics geometry and of the model utilized is presented, together with a FORTRAN simulation of the MK86 computer program and a listing of the ballistics tables used in this system.

TABLE OF CONTENTS

I.	INTRODUCTION-----	8
	A. GENERAL DESCRIPTION -----	8
	B. PROBLEM DESCRIPTION -----	8
	C. SUMMARY-----	9
II.	INTRODUCTION TO MK 86 BALLISTICS-----	10
	A. BALLISTICS SETUP -----	10
	B. BALLISTICS ACQUISITION -----	11
	C. DETERMINATION OF POINT 2 -----	11
	D. CALCULATION OF POINTS 21 AND 22 -----	12
	E. BALLISTICS ITERATION-----	12
	F. CLOSURE TESTS-----	13
	G. BALLISTICS OUTPUT -----	13
III.	BALLISTICS EFFECTS MODELING -----	19
	A. CATEGORY-ONE PARAMETERS-----	19
	B. CATEGORY-TWO PARAMETERS -----	21
	C. CATEGORY-THREE PARAMETERS -----	21
IV.	THE BALLISTICS TABLES -----	23
	A. MK 86 MACHINE LANGUAGE TABLES -----	23
	B. BALLISTICS TABLES IN THE FORTRAN SIMULATION -----	24

V.	BALLISTICS SUBPROGRAMS	26
A.	TARG1	26
B.	TARG2	27
C.	BCOMPA	28
D.	BCOMPB	28
E.	BCOMPC	28
F.	BCOMPD	29
G.	BCOMPE	29
H.	BCOMPF	29
I.	BCOMPG	29
J.	BCOMPH	30
K.	BCOMPI	30
L.	BCOMPJ	30
M.	BCOMPK	31
N.	TARG3	31
O.	TARG4	31
P.	TMONIT	32
Q.	AASRCH	32
R.	SEARCH	33
S.	POLYN	33
T.	INTERP	33
U.	DECSI	34
V.	SLIDE	34

W. FINDAL -----	34
X. CORLIS -----	34
Y. DRIFT -----	34
Z. GUNMOT -----	35
AA. RTWT-----	35
AB. WIND -----	35
AC. ZLIMIT -----	35
VI. FORTRAN SIMULATION -----	41
A. ASSUMPTIONS -----	41
B. FORTRAN PROGRAM-----	41
C. VERIFICATION -----	42
COMPUTER PROGRAM -----	43
LIST OF REFERENCES -----	123
INITIAL DISTRIBUTION LIST-----	124
FORM DD 1473 -----	126

LIST OF TABLES

I.	TYPICAL BALLISTICS TABLE FOR ONE PARAMETER---	20
II.	BALLISTICS TABLES (FORTRAN) -----	25

LIST OF FIGURES

I.	BALLISTICS CLOSURE GEOMETRY-----	14
II.	FUNCTIONAL FLOW CHART-----	15
III.	BALLISTIC MODEL-----	22
IV.	PARAMETER AS A FUNCTION OF RANGE AND ELEVATION-----	22
V.	FORTTRAN FLOW CHART-----	36

I. INTRODUCTION

A. GENERAL DESCRIPTION

The GFCS MK86 is the first digital gun-fire control system to be considered by the U. S. Navy. It is designed to control the 5"/54 gun-mount and to solve the fire control problem for the air, surface, shore-direct or shore-indirect modes of operation. In this thesis only the AA cartesian ballistics mode is considered.

B. PROBLEM DESCRIPTION

A computer simulation program was felt to be a prerequisite to a complete study and analysis of the GFCS MK86 AA model. This in turn necessitated a careful study of the existing documentation and machine-language software of the MK86 system.

The FORTRAN simulation of the MK 86 AA mode was divided into three sections: The pre-filter processing section, programmed by LT J. D. GORMAN; The three-dimensional numerical filter, by LT T. J. WILL; and the ballistics section contained in this thesis. These three programs can process radar target information from target detection to ballistics output prior to the generation of gun orders.

Another objective of this project was the generation of adequate documentation of the system. This phase was also divided into the three sections described in the previous paragraph.

C. SUMMARY OF INTRODUCTION

This thesis contains a description of the MK86 ballistics program including the ballistics intercept geometry, ballistics model used, and sequence of ballistics computations. A description of each subprogram indicating its function is also presented. The FORTRAN simulation program including the ballistics tables is listed and differences between the machine-language program and the FORTRAN program are indicated.

II. INTRODUCTION TO MK86 BALLISTICS

The GFCS MK86 ballistics program accepts stabilized and filtered target position and rate data, together with ownship's data, and computes the gun ballistics required for the generation of gun pointing and fuze orders.

A. BALLISTICS SETUP (I. E. INITIALIZATION)

The ballistics parameters such as air temperature, air density, wind, and initial velocity are entered at the console and corresponding increments from nominal values are computed.

Target and ownship's data are used to compute the target's present position and rate relative to the gun's position at ballistics time. This position of the target is called point 1 (see Figure 1), and is computed in spherical coordinates. The relative rates are resolved into range and crossrange components.

A test is made to determine whether the input data is associated with a new target. If it is, an acquisition mode is declared and the processing sequence calls the acquisition subprogram. In the case of an old target, track mode is designated and the acquisition subprogram is bypassed. This is illustrated in the flow chart of Figure 2.

B. BALLISTICS ACQUISITION

Before a ballistics solution can be developed, a first estimate of future target position is required. This is called the advance position, or point 3 (see Figure 1). If the system has been tracking the target, then the last ballistics solution, updated, serves as the advance position. With a new target, however, some other means for estimating a reasonably accurate point 3 is necessary. This is the function of the ballistics acquisition subprogram (see Figure 2).

In the acquisition phase, point 3 is computed as follows. The projectile time of flight to the present target position (point 1) is computed from the ballistics table in the normal way (see Section III). Using this time of flight and the target's present position and velocity, an estimate is made of the target's future position (point 3). A number of logical tests are employed to check the validity of the estimate. The slant range, bearing, and elevation of point 3 are designated R3, BY3, and E3 respectively.

C. DETERMINATION OF POINT 2

The ballistics program next uses the advance position of the target (point 3) as the aim point and computes a predicted "impact" point from the ballistics tables. This is called point 2 and the corresponding slant range, bearing, elevation, and time of flight are designated R2, BY2, E2, and T2, respectively. These values differ

from the point 3 quantities due to non-nominal powder and air temperatures, and because of coriolis, drift, and wind effects.

D. CALCULATION OF POINTS 21 AND 22.

The target position which corresponds to the computed time of flight T_2 is calculated and designated as point 21 (see Figure 1). Then the differences in slant range, bearing and elevation from those at point 2 (the predicted projectile impact point) are computed. These increments are designated IR_{21} , IBY_{21} , and IE_{21} , respectively, and a corresponding linearized estimate of the time of flight increment IT_2 is computed.

Finally the point 21 target position is updated by the time increment IT_2 to determine point 22 (see Figure 1), which is the first estimate of the point where the target and projectile will coincide in both position and time.

E. BALLISTICS ITERATION (I. E. SECOND PASS)

After point 22 has been calculated once, as indicated in the preceding sections, the program uses point 22 (modified) as a new (improved) point 3 and goes through the calculation to point 22 a second time. This is shown in Figure 2. Finally the increments IR_{22} , IBY_{22} , IE_{22} , and IT_{22} between point 2 and point 22 are computed for use in the ballistics output program.

F. CLOSURE TESTS

A test is made at the end of each of the two passes described above to determine if the final point 22 is a valid (i. e. accurate) solution. This is done by comparing point 21 data and point 2 data, which is called the closure test. The test after the first pass merely sets a flag, which is used to modify the criterion used in the test which follows the second pass. If the second-pass solution fails to close, then the computation aborts for this time interval.

G. BALLISTICS OUTPUT

If closure has occurred, the gun elevation, bearing and time of flight which were calculated with point 2 as the aim point are modified by the amount necessary to move the impact point to point 22. This data is then transmitted to the gun and fuze order programs.

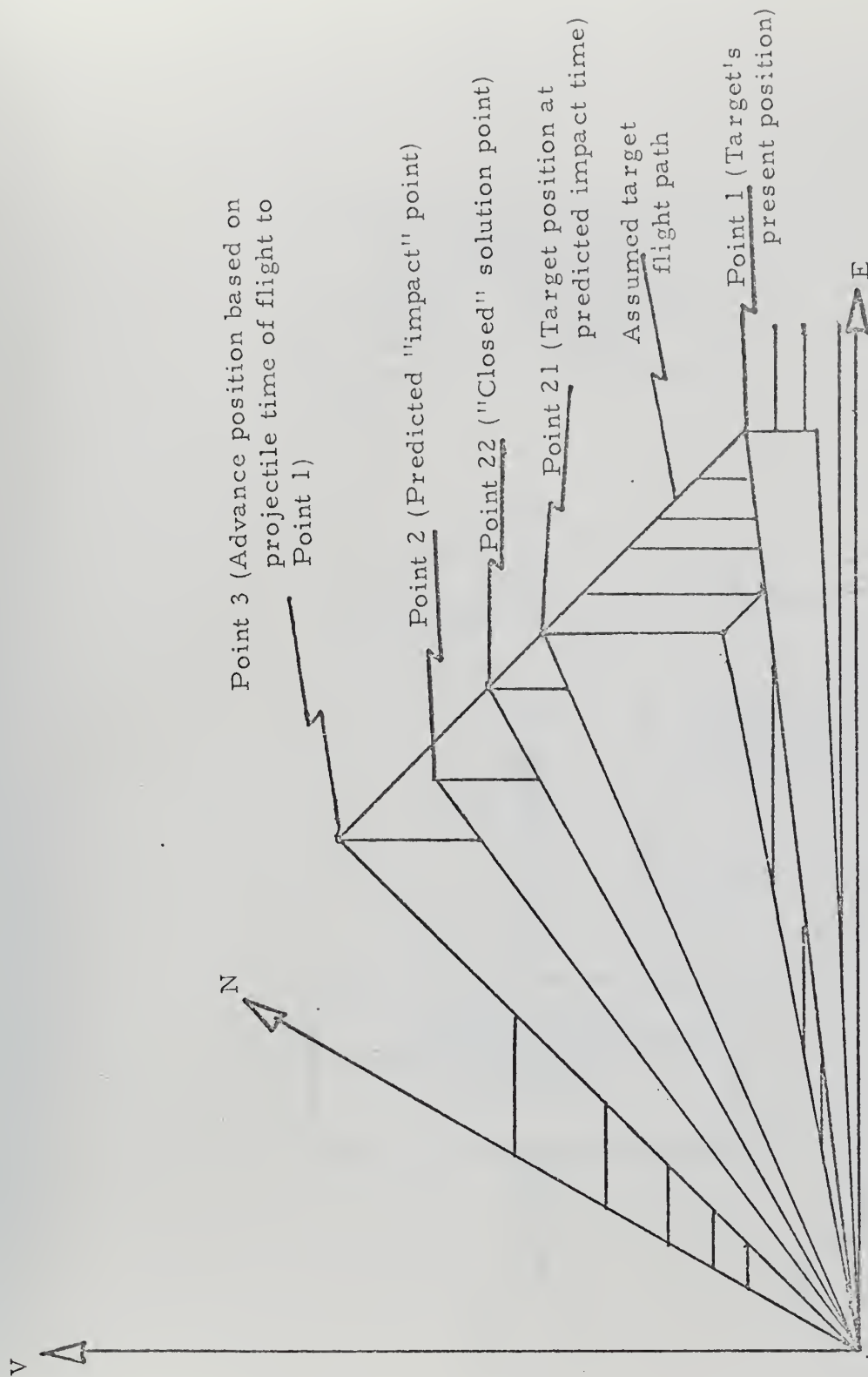


Figure 1
GFCS MK 86 BALLISTICS CLOSURE GEOMETRY

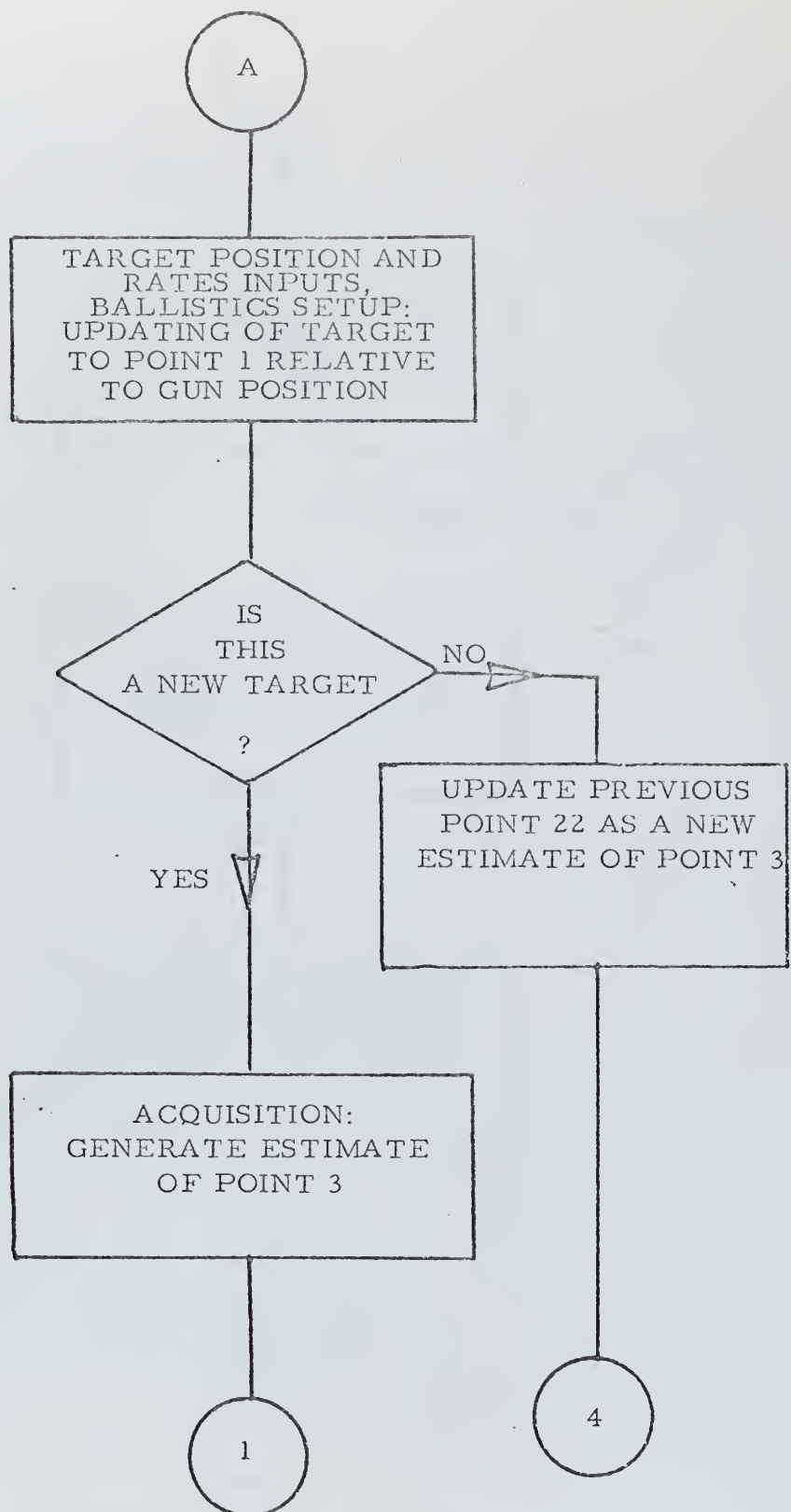


Figure 2
FUNCTIONAL FLOW CHART

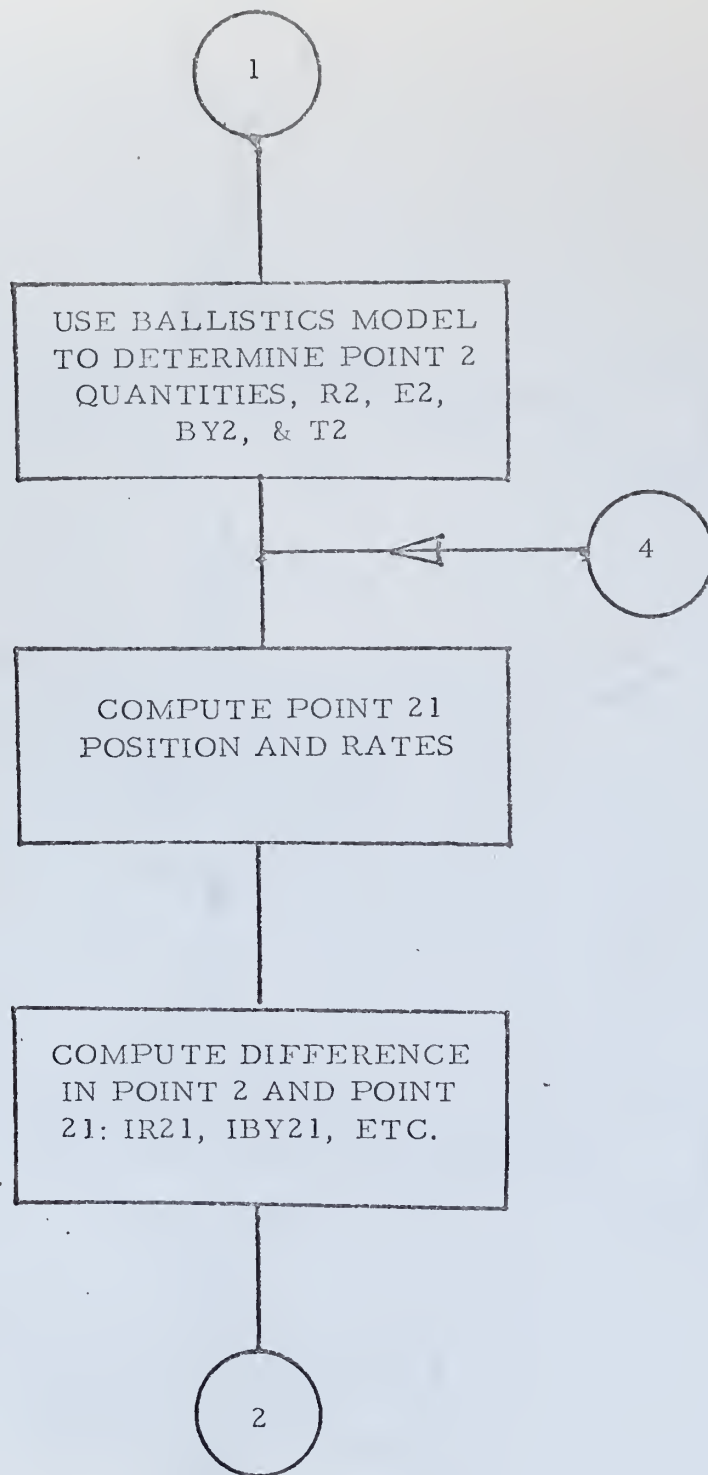


Figure 2
FUNCTIONAL FLOW CHART

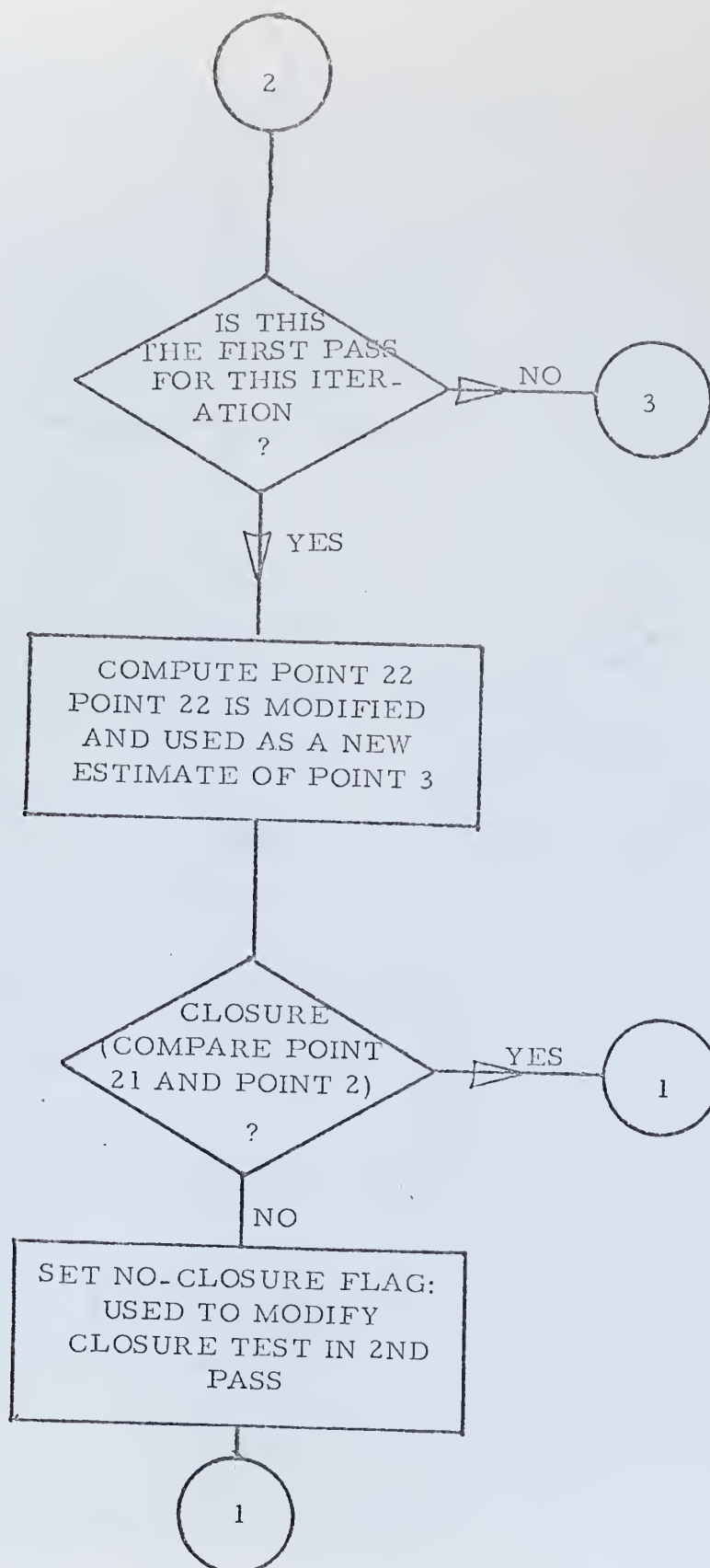


Figure 2
FUNCTIONAL FLOW CHART

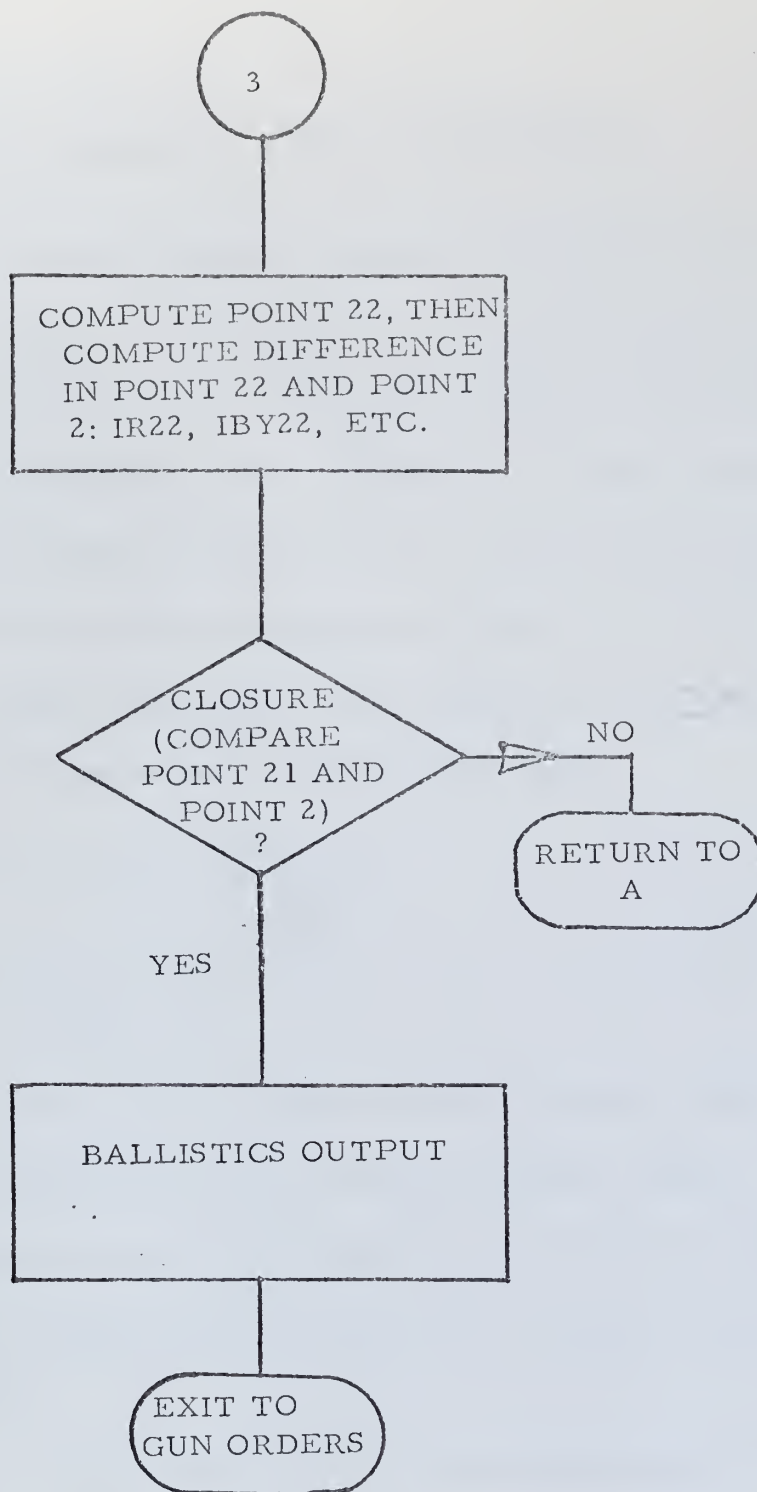


Figure 2
FUNCTIONAL FLOW CHART

III. BALLISTICS EFFECTS MODELING

The MK86 ballistics modeling program provides the means for determining the values and effects of the various ballistic parameters. The approach taken and the structure of the modeling is described here for AA cartesian ballistics (see Figure 3). The basic function of the model is to provide projectile impact or intercept point parameters based on advance target position parameters (that is, to provide point 2 output data from point 3 input data). The ballistics parameters are broken down into the three categories described below.

A. CATEGORY-ONE PARAMETERS

1. Gun elevation angle, EG
2. Time of flight, T3
3. Range effect per unit initial velocity variation, DRDU
4. Range effect per unit air density variation, DRDH
5. Range effect per unit air temperature variation, DRDTF
6. Time of flight effect per unit initial velocity variation,
DT3DU
7. Time of flight effect per unit air density variation, DT3DH
8. Time of flight effect per unit air temperature variation,
DT3DTF

Each of these parameters is modeled by a cubic polynomial function of range of the form:

$$F = K_0 + K_1(IR_3) + K_2(IR_3)^2 + K_3(IR_3)^3$$

$$= K_0 + IR_3(K_1 + IR_3(K_2 + K_3(IR_3)))$$

Where F is the parameter to be determined and the K's are coefficients obtained from tables which are arranged in elevation "stacks", each of which is "partitioned" according to slant range. This is illustrated by the table below:

TABLE 1
Typical Ballistics Table for One
Parameter (such as Time of Flight)

Stack 1	Stack 2	Stack N
Stack elevation angle #1	Stack elevation angle #2	Same format as other stacks
List of range intervals in this stack	List of range intervals in this stack	
Coefficients for first range interval	Coefficients for first range interval	
Coefficients for 2nd range interval	Coefficients for 2nd range interval	
etc.	etc.	

The quantity IR 3 in the above cubic polynomial is the incremental slant range (i. e. the slant range of interest minus the lower range bound of the range partition in use).

That is, each category-one parameters is modeled by a cubic equation in each range-elevation partition, as shown in Figure 4. It is the coefficients of the cubics that are provided by the ballistic tables. In the simplest case, two values of F are computed, one corresponding to each of the elevation stacks which bracket the actual elevation. The final value of F then follows from linear interpolation.

B. CATEGORY-TWO PARAMETERS

1. Coriolis effects on range, crossrange and time of flight
2. Drift effect
3. Angle of fall factor and calculation of tangent of the angle of fall

Each of these parameters is modeled by an analytic expression modified by a correction factor which is calculated in essentially the same way as a category-one parameter. In this case the factor K is computed by a linear incremental slant range relation, $K=C_0+C_1(IR_3)$.

C. CATEGORY-THREE PARAMETERS

1. Range effect per unit projectile weight variation
2. Time of flight effect per unit projectile weight variation
3. Wind and motion effects on range and crossrange

These parameters are calculated in special subroutines which do not require range and/or elevation dependent table lookup.

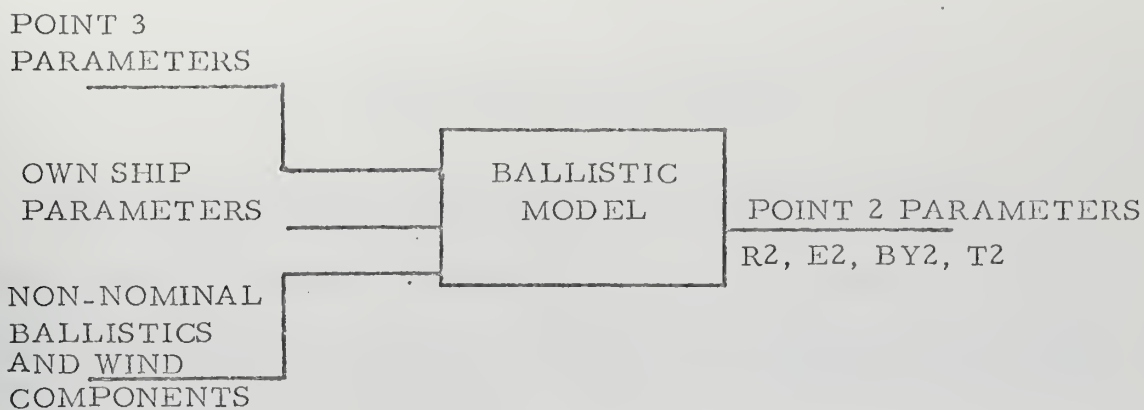


Figure 3
BALLISTIC MODEL

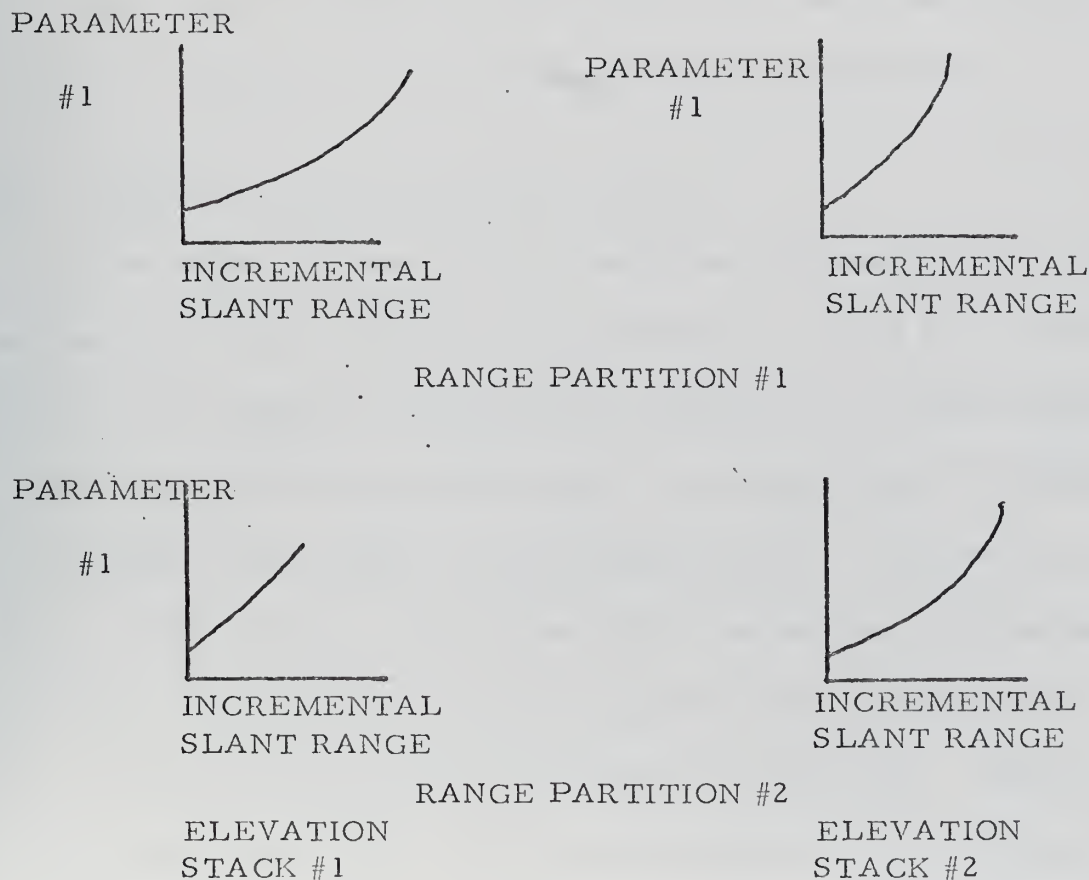


Figure 4
PARAMETER AS A FUNCTION OF ELEVATION AND RANGE

IV. THE BALLISTICS TABLES

The ballistics tables were derived by modeling range table data provided LEC by NWL Dahlgren [Ref. 1]. There are six sets of tables. Each table corresponds to one or more ballistics parameters. The AA tables are of the following form:

1. Each parameter's section of the table is divided into elevation stacks.
2. Each elevation stack is divided into range partitions or intervals.
3. For each range partition there are a set of coefficients which are used to evaluate the chosen parameter.

A. MK86 MACHINE LANGUAGE TABLES

The tables are located in the computer in sequential order. The address of the first entry for each parameter is stored in the ETABAD matrix. This address is also stored in ISRCH(1). To find the address of the first elevation stack to be used, the address stored in ISRCH(1) is modified by the contents of the PUSHTB matrix. The first 8 bits of each PUSHTB entry contains the number of entries to be bypassed in order to locate the address of the initial elevation stack for the low elevation AA mode (advance elevation less than 35°). The last 8 bits indicate the number of entries to be bypassed for the high elevation AA mode. The modified address is then stored in ISRCH(2).

The first entry of each elevation stack contains:

1. Stack elevation angle
2. Number of range partitions, minus one
3. Internal shift count

The stack elevation angle is stored in STACK(3), the number of range partitions is stored in the NP matrix, and the internal shift count necessary to position the binary point in the KSH matrix.

A complete listing of the tables may be found in reference 2.

B. BALLISTICS TABLES IN THE FORTRAN SIMULATION

The entry into the the organization of the tables is different in the FORTRAN simulation program from that in the machine language program.

The ballistics tables are stored in a three-dimensional array. The coordinates of the matrix are parameter, elevation stack angle, and the location of a particular item in the stack. The first entry in a particular elevation stack is the elevation stack angle, and it is followed by the number of range partitions. Then the limits of the range partitions are listed, followed by the coefficients for each range partition. The location in a stack of the first coefficient required is calculated by multiplying the number of coefficients times the number of the range partition of interest and adding the location of the first range partition plus 3. Then the location is stored in T17. A listing of the ballistics tables starts on page 90 . In this listing,

each table corresponds to a ballistic parameter (see Table 2), and each column corresponds to an elevation stack.

TABLE 2
Ballistic Tables (FORTRAN)

Table	Parameter
1	Time of flight (T3)
2	Super-elevation angle (EGB)
3	Range effect due to change in initial velocity (DRDU)
4	Time of flight effects due to change in initial velocity (DT3DU)
5	Range effect due to change in air density (DRDH)
6	Time of flight effects due to change in air density (DT3DH)
7	Range effect due to change in air temperature (DRDTF)
8	Time of flight effects due to change in air temperature (DT3DTF)
9	Tangent of angle of fall (TANW)
10	Coriolis effects
11	Drift effects

V. BALLISTICS SUBPROGRAMS

Since this project was concerned only with the AA aspect of the GFCS MK86 system, all references to surface ballistics, grid mode, ROS mode, TDT mode, and spherical ballistics have been omitted. For the flow chart of the subprograms see Figure 5. A complete explanation and flow chart may be found in References 3 and 4.

A. TARG1

This subprogram freezes or holds the console inputs for the duration of the $\frac{1}{2}$ second ballistics computation cycle, and calculates and sets the following indicators:

1. AA ballistics
2. Cartesian ballistics
3. Ammo type, charge
4. Gun and gun control console assignments
5. Target assignment
6. Acquisition or tracking ballistics

In addition, TARG1 computes non-nominal increments that may exist in various ballistics parameters, performs a ship's course update, and determines gun parallax corrections. Calculations are also performed to update the target data to "ballistic time" (i. e., the next "integer" $\frac{1}{2}$ second).

B. TARG2

This subprogram performs the acquisition ballistics computations for AA cartesian ballistics. Its function is to calculate point 3 (the theoretical aiming point) from point 1 (the target position at ballistics time). This subprogram determines the first advance position (aim point) when no valid prior advance position exists. This situation would occur whenever:

1. A new AA target has been assigned
2. There was no ballistics solution during the previous $\frac{1}{2}$ -second ballistics computation cycle
3. There has been a change in the mode assignment for the gun
4. There has been a change in the ammo type or charge

The countdown flag (KGOOD) is set to one, indicating that the acquisition subprogram must be completed more than once before the gun is released from any previous state it may have been in. The acquire flag is set to one to indicate the acquisition ballistics mode.

The advanced elevation (E3) is set equal to the elevation angle at point 1 (E1). TMONIT, which controls the ballistic table computations, is then entered to find the nominal time of flight (T1) from RC, the range to point 1.

C. BCOMPA

This subprogram computes the time of flight to point 3 (T3) and its derivatives with respect to range and elevation. It also computes the mixed second partial derivative with respect to range and elevation. Using E3 and R3 as inputs, TMONIT is called and the time of flight is returned in TEMP2, the range derivative (DT3DR) in TMP3, the elevation derivative (DE3DE) in DPDEP, and the mixed partial (DT3RDE) in DPDED.

D. BCOMPB

This subprogram computes the super elevation angle (EGB) and its derivatives with respect to range and elevation, as well as the mixed second partial with respect to range and elevation. TMONIT is called and the super elevation angle is returned in TEMP2, the range derivative in TMP3, the elevation derivative (DEGDE) in DPDEP, and the mixed partial (DEGRDE) in DPDED. Then EGB and E3 are summed to form the total elevation angle $E4=E3+EGB$, which is limited to a maximum of 85 degrees.

E. BCOMPC

This subprogram computes the derivative of range with respect to a non-nominal increment of projectile velocity (DRDU) and the derivative of DRDU with respect to elevation (DRDUDE). Then the actual range effect (URH) due to non-nominal projectile velocity is computed.

F. BCOMPDP

This subprogram computes the derivative of the time of flight with respect to the increment in projectile velocity (DR3DU) and the time of flight effect (UT3) due to non-nominal projectile velocity.

The mixed second partials of time of flight with respect to increment in projectile velocity and elevation (DT3UDE) and range (DT3UDR) are also computed.

G. BCOMPE

This subprogram computes the derivative of range with respect to non-nominal increments in air density (DRDH) and the derivative of DRDH with respect to elevation (DRDHDE). Then the actual range effect due to non-nominal ballistic air density (HRH) is computed.

H. BCOMPF

This subprogram computes the derivative of time of flight with respect to a non-nominal increment in air density (DT3DH) and the actual time of flight effect (HT3) due to DT3DH. The mixed second partials of time of flight with respect to air density and range and elevation (DT3HDR, DT3HDE) are also computed.

I. BCOMPG

This subprogram computes the derivative of the range with respect to a non-nominal increment in surface air temperature (DRDTF),

the actual range effect (TFR3), and the mixed partial of range with respect to temperature and elevation (DRTFDE).

J. BCOMP H

This subprogram computes the derivative of time of flight with respect to a non-nominal increment in surface temperature (DT3DTF); computes the actual time of flight effect (TFT3) due to air temperature; and calls the weight effect subprogram (RTWT).

The subprogram then performs a partial sum of all the range effects and time of flight effects calculated so far and calculates the derivative of the time of flight to point 2 (the predicted impact point) with respect to range (DT2DR).

K. BCOMP I

This subprogram computes the downrange and crossrange components of gun motion (DMR3OG, DMGOG) before calling GUNMOT, the gun motion subprogram. It then computes the tangent of the angle of fall (TAN W) and calls the wind effects subprogram, WIND.

L. BCOMP J

This subprogram obtains a first partial sum of range effects, a second partial sum of time of flight effects, and calls CORLIS to obtain coriolis effects.

M. BCOMPK

This subprogram computes the intercept geometry by determining the horizontal range, vertical range, slant range, and bearing to the predicted projectile impact point (point 2). It also computes the elevation angles for the gun.

N. TARG3

This subprogram performs the iteration and closure computations. Its function is to update through two iterations the previous advanced aim point (point 3) such that satisfactory coincidence is obtained between the predicted impact point (point 2) and the predicted target position at impact time (point 21). The closure equations determine when there is sufficient closeness between the two points for an acceptable solution.

The input values to TARG3 come from two sources. In the tracking mode, the data from the previous pass through TARG3 to BCOMPK is used to update current values. In the acquisition mode, the values calculated in subprograms TARG2 through BCOMPK are used.

O. TARG4

This subprogram computes the ballistics outputs. It computes the final inertial gun orders, gun order rates, and fuse time rate as well as the inertial impact coordinates and rates for eventual display

on the B-scan. These computations are oriented to the start of the next 1/16 second time-slice.

P. TMONIT

For a given parameter, this subprogram does the initial setup and locates the proper table and elevation stack corresponding to the target's elevation. Then it calls appropriate subprograms to calculate the value of the parameter from the chosen table.

In more detail, either two or three stacks are selected so that their elevation values bracket the value of E3. Two are selected for parameters which are linearly interpolated with respect to elevation and three for those which are parabolically interpolated. The partition selection, coefficient look-up, and polynomial evaluation with respect to range are performed on each of the selected sets of coefficients yielding a value of the parameter and its derivatives corresponding to each of the bracketing elevations. The final value of the parameter and its derivatives are then obtained by interpolating with respect to elevation.

Q. AASRCH

This subprogram controls the selection of coefficients for bracketing elevation stacks, the cubic polynomial evaluation, and the interpolation between elevation stacks. It also controls the calculation of the appropriate derivatives. For standard tables (four

coefficients per partition) the address of the first coefficient is found by calling the SEARCH subprogram. Then the polynomial subprogram is called to evaluate the parameter, which is stored, with its derivative, in the STACK matrix. When all parameters and derivatives corresponding to the selected elevation stacks have been evaluated, then the interpolation subprogram is called to get the final values. For non-standard tables, only the address of the first coefficient is found for each selected elevation stack. These values are stored in the HOLDB3 matrix.

R. SEARCH

This subprogram, which is called by AASRCH, finds the correct range partition and the location of the first coefficient for that range partition.

S. POLYN

This subprogram, which is called by AASRCH, evaluates the polynomial from the coefficients and finds the derivatives with respect to range for each elevation stack chosen.

T. INTERP

This subprogram performs linear or parabolic interpolation on a set of two or three parameter values with respect to elevation. The interpolated value is the value of the parameter at the actual advance elevation.

U. DECSI

This subprogram decodes the elevation information from each stack and stores it in STACK(3).

V. SLIDE

This subprogram moves the parameters stored in the STACK matrix up one location.

W. FINDAL

This subprogram finds the location of the next available elevation stack.

X. CORLIS

This subprogram computes ballistic Coriolis effects for slant range, altitude, time of flight, crossrange and downrange effects. The Coriolis table is a non-standard table with six coefficients per range partition. Three linear coefficients are computed and used to determine the effects of Coriolis.

Y. DRIFT

This subprogram computes the crossrange effect of projectile drift. The drift effect table is a non-standard table with two coefficients per range partition. Two polynomials are evaluated for AA ballistics, one for each elevation stack bracketing the actual advance elevation.

Z. GUNMOT

This subprogram calculates the ballistic effect due to gun motion (i.e. the advance range, time of flight, deflection and cross-range effects). Under conditions of no gun motion, the projectile leaves the muzzle with an initial velocity vector (U) at inertial true bearing BGY, and inertial elevation, EG. With gun motion, the component along the U vector will increase the magnitude of U .

AA. RTWT

This subprogram calculates the (minor) effect of projectile weight on time of flight and range. Due to inertia, an increase of projectile weight will produce a decrease of initial velocity. It will also produce a decrease in drag acceleration, which is equivalent to a decrease in air density. Thus the range and time of flight effects due to a projectile weight variation can be computed as the sum of the equivalent effects of increments in initial velocity and ballistics air density.

AB. WIND

This subprogram calculates the total effects of wind on advance range, time of flight, and crossrange.

AC. ZLIMIT

This subprogram limits the Z coordinate of a target to a minimum value, based upon target horizontal range, earth's curvature, and height of the gun above the sea surface.

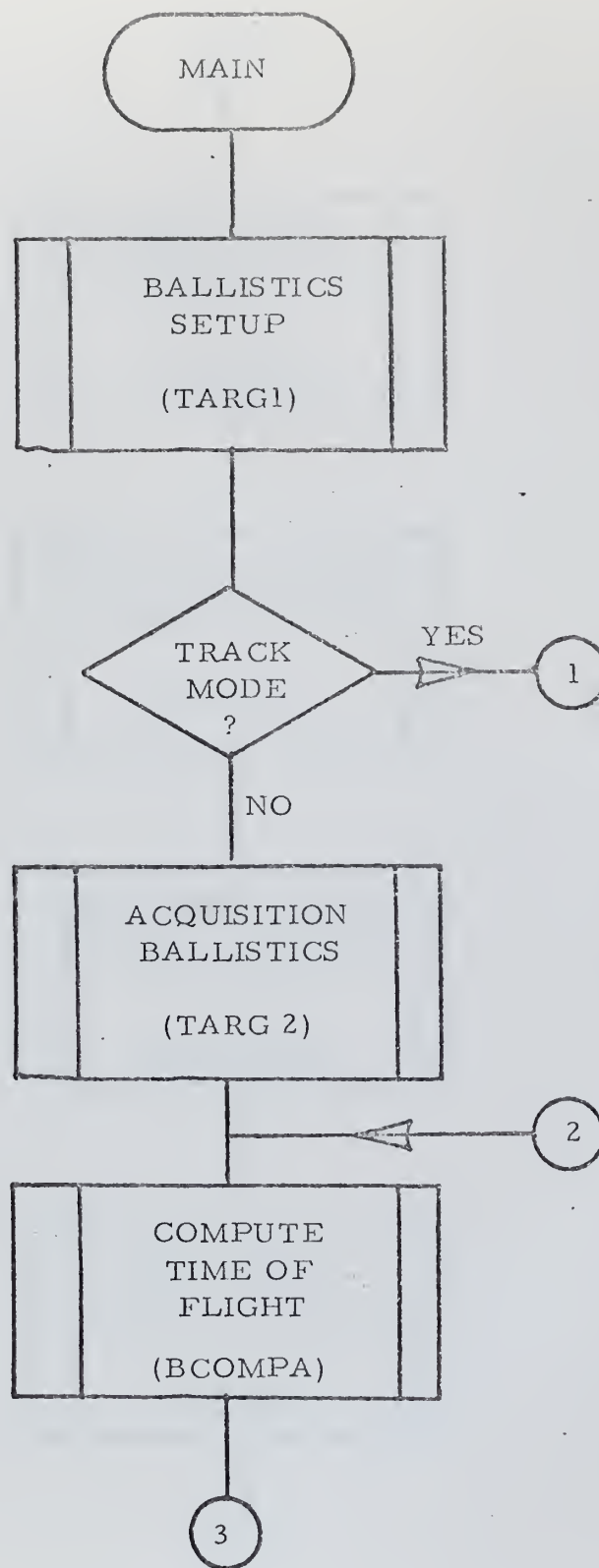


Figure 5
FORTRAN FLOW CHART

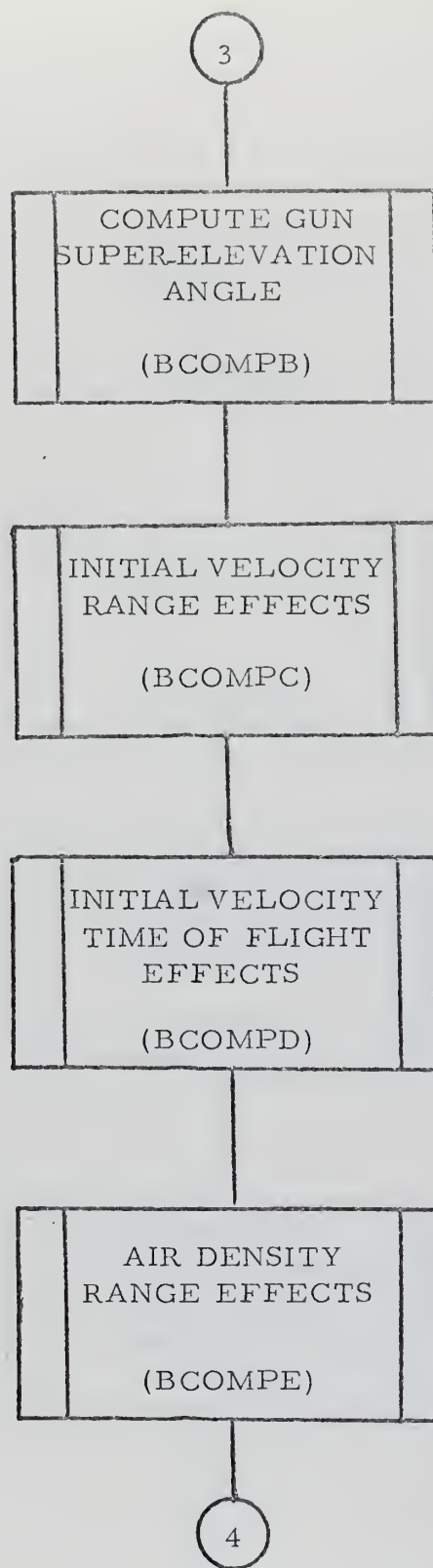


Figure 5
FORTRAN FLOW CHART

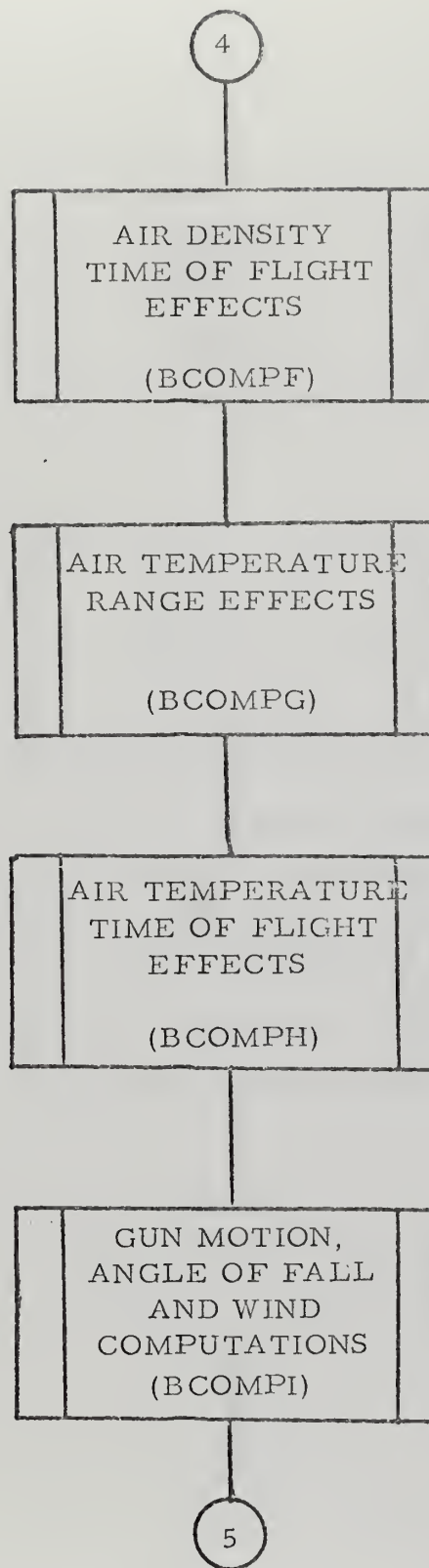


Figure 5
FORTRAN FLOW CHART

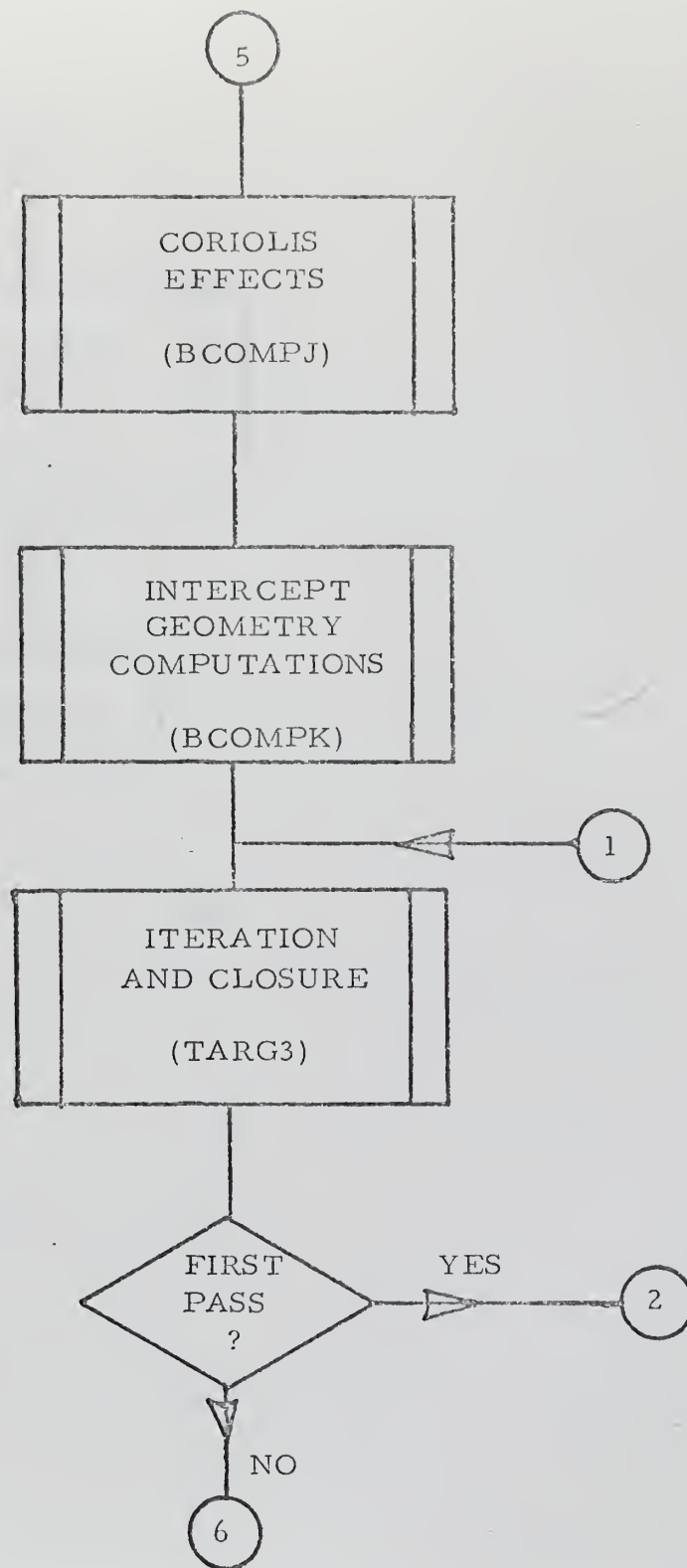


Figure 5
FORTRAN FLOW CHART

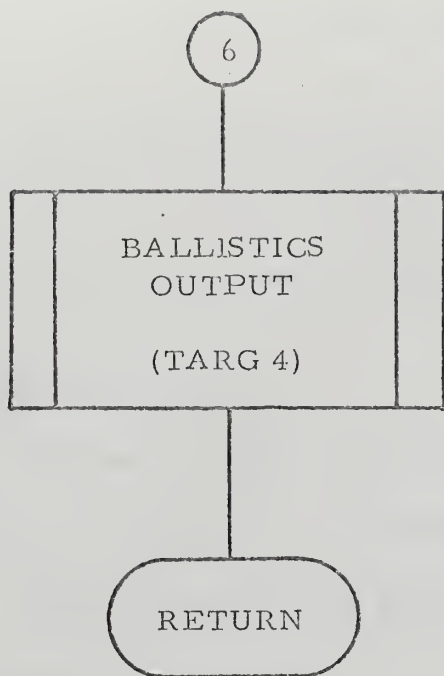


Figure 5
FORTRAN FLOW CHART

VI. FORTTRAN SIMULATION

Since only the AA mode was to be considered, all flags and variables necessary to indicate the AA mode were pre-set to insure that only the AA cartesian ballistics computations were performed.

A. ASSUMPTIONS MADE

The FORTRAN program has no real time clock, therefore certain timing assumptions had to be made. These assumptions are:

1. JOELCK (target valid data-time for ballistics)
equals $-1/32$ second
2. TBR (saved value of ballistic time) was initialized
to 0
3. TB (ballistics time to next second) initialized to
 $\frac{1}{4}$ second
4. TBFIN (final ballistics time for next $1/16$ second
initialized to $15/32$ second

B. FORTRAN PROGRAM

The program, which is listed starting on page closely follows the arrangement of the MK86 machine language program. It has been suitably annotated with comment cards, and otherwise should be self-explanatory. It has been written so that all ranges are in yards, and all angles are in degrees.

Three internal subprograms (DECSI, SLIDE, AND FINDAL) of TMONIT in the machine language program have been treated as separate subprograms in the FORTRAN program. Also, in BCOMPB the super-elevation angle is computed in minutes and then converted to degrees.

C. VERIFICATION

Complete verification of the FORTRAN program was not done due to lack of sufficient data. The separate subprograms were verified by calculations done by hand. Using data furnished by LEC, a partial verification was attempted. However, effects such as wind, coriolis, non-nominal parameters and ship's motion had been set to zero in the data provided [Ref. 5].


```

COMMON/RT/COS1,SIN1,TAN
COMMON/CA/T3,DT3DR,DT3DE,DT3RDE
COMMON/CB/COSE4,DEGDE,DEGDR,EGB1,E4,SINE4,DEGRDE
COMMON/CC/DRDU,DRDUDE,URH
COMMON/CD/DT3CU,DT3UDR,DT3UDE,UT3
COMMON/CE/DRDH,DRDHDE,HRH
COMMON/OE/HT3,DT3DH,DT3HDE,DT3HDR
COMMON/CG/DRTFDE,DRDTF,TFR3
COMMON/CH/TFT3,DT3FDE,JIR3,R2J1,WTR3,WTT3,T2J1,DT2DR
C,DT3DTF
COMMON/I/ANGLEW,DMR3OG,DMBOG,SINEGB,COSEGB,TANEG,
CTANW,TOVERW
COMMON/CJ/J2R3,R2J2,T2J2
COMMON/CK/R2,E2,T2,BY2
COMMON/AL/KORIND,STACK(11),HOLDB3(3),PRDET,IR3,EXACTE,B6,
CDPE,ISRCH
COMMON/A2/TABLE(11,17,32),K,T17,LIMVIO
COMMON/TG1/RCOEFF(8),KMTABL(11,2),ETABL(17,11),PUSHTB(11,2)
COMMON/CGU/DRDMY,DT3DMY,DT3MEY,MR3CR3,MR3OT3,MOLS,MORLS
COMMON/CDR/DORLS
COMMON/CCR/KRLS,KR3,KTRRE3,KT3,T2J2SQ,TANE4
COMMON/CW/DRDWRH,DTDWRH,WBG,WRHG,WRLS,WR3,WT3
COMMON/OZ/RHGEN,RZGEN
COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
COMMON/N2/BCCOUNT
COMMON/T1/ROX,ROY,DWOX,DMGY,ROXY,RCYY,RXL,RYL,RZL,CMCXY,DMOY,
CRTX,DRTY,DRTZ
COMMON/T12/SINLAT,CCSLAT,CQO,DCQC,SINLAR,CCSLAR
COMMON/T13/WX,WY,WXR,WYR
COMMON/T24/QALS,QAR2,QAV,ERVG,QR3,QRLR,QVR,RV
COMMON/T151/ZSUBN(3),CDMTZ(3)
COMMON/T16/DSU,DTF,DAT,PWDTMP,DH
COMMON/T17/BALL1,NEW3DT,NOCLOS,AQUIRE,ICCOUNT,KGOOD,BALIND
COMMON/T18/AARO,RNGDOT,RC
COMMON/T19/TB,TBR
COMMON/T120/IH,IPT,ITF,IU,IWT,HO,UO
COMMON/T121/E1,BYL
COMMON/T21/RTTEMP,R3,RX3,RY3,RHOLD
COMMON/T22/E3,SINE3,COSE3,BY3,SINBY3,COSBY3
COMMON/T3/RX21,RY21,DMRT21,DE21,DBY21,E21
COMMON/T31/BY22,IBY22,E22,R22,IT2
COMMON/T4/BGYAUP,BTT2,DBGY,DEG,DT216,DT5,EGAUP,FLASH,LITSET,CE,QLS,TT2
INTEGER*4 T17,PUSHTB
REAL*4 LCQO
REAL*4 IR3
REAL*4 ITB
REAL*4 KRLS,KR3,KTRRE3,KT3
REAL*4 IT2,IT2X

```



```

10
11
12
3
12
4
5
13
6
9
8
21
20
23
22
25
24
INTEGER*4 ETABL1
REAL*4 JOELCK
DO 1 I=1,8
  READ(5,10) RCOEFF(I)
  FCORMAT (E15.8)
  CCNTINUE
DO 2 I=1,17 (ETABL1(I,J),J=1,11)
  READ(5,11) (11I5)
  FCORMAT (11I5)
  CCNTINUE
DO 3 I=1,11
  STACK(I)=0
  CCNTINUE
DO 4 I=1,11 (KMTABL(I,J),J=1,2)
  READ(5,12) (KMTABL(I,J),J=1,2)
  FCORMAT (2I5)
  CCNTINUE
DO 5 I=1,11 (PUSHTB(I,J),J=1,2)
  READ(5,12) (PUSHTB(I,J),J=1,2)
  CCNTINUE
DO 6 J=1,15
  DO 7 N=1,32
    READ(5,13) TABLE(1,J,N)
    FCORMAT (E15.8)
    CCNTINUE
DO 8 J=1,17
  DO 9 N=1,32
    READ(5,13) TABLE(2,J,N)
    CCNTINUE
DO 20 J=1,11
  DO 21 N=1,12
    READ(5,13) TABLE(3,J,N)
    CCNTINUE
DO 22 J=1,4
  DO 23 N=1,12
    READ(5,13) TABLE(4,J,N)
    CCNTINUE
DO 24 J=1,8
  DO 25 N=1,17
    READ(5,13) TABLE(5,J,N)
    CCNTINUE
DO 26 J=1,4
  DO 27 N=1,12

```

```

MAI000050
MAI000060
MAI000070
MAI000080

MAI000100
MAI000110
MAI000120
MAI000130
MAI000140
MAI000150
MAI000160
MAI000170
MAI000180
MAI000190
MAI000200
MAI000210
MAI000220

MAI000240
MAI000250
MAI000260
MAI000270
MAI000280

```



```

27 READ(5,13) TABLE(6,J,N)
26 CONTINUE
   DO 28 J=1,11
   DC 29 N=1,17 TABLE(7,J,N)
   CONTINUE
   DO 31 J=1,4
   DC 32 N=1,12 TABLE(8,J,N)
   CONTINUE
   DO 33 J=1,17
   DC 34 N=1,13 TABLE(9,J,N)
   CONTINUE
   DO 35 J=1,3
   DC 36 N=1,9 TABLE(10,J,N)
   CONTINUE
   DO 37 J=1,5
   DC 38 N=1,11 TABLE(11,J,N)
   CONTINUE
   KCRIND=4
   RHO=0
   RTEMP=0
   TEM2=0
   TMP3=0
   T10=0
   ICODEP=0
   DPDED=0
   BCCOUNT=0
   K=0
   TEST RUN VALUES ALL SHIP'S PARAMETERS SET TO 0, USE ALL NONIMAL VALUES
   FCR AMMC
   PWCTMP=90
   DSU=2500
   DTF=59
   DT=100
   WX=0
   WY=0

```

CC

MAI000300
MAI000310
MAI000320
MAI000330
MAI000340
MAI000350
MAI000360
MAI000370
MAI000380
MAI000390


```

QALS=0
QAR2=0
QAV=0
DCQO=0
RCX=0
RCY=0
DMOXY=0
CGC=0
BALL1=1
RNGDOT=-280
AARC=2300
ERVG=975
CCSLAT=1.0
SINLAT=0.0
DC 1000 J=1,3
DC 200 N=1,3 CDMRTZ(N)
WRITE(5,13) CDMRTZ(N)
FCRNAT(10X,E15.8)
CONTINUE
DC 201 N=1,3 ZSUBN(N)
WRITE(6,700) ZSUBN(N)
CONTINUE
CALL TARG1 EQ.0) GO TO 1000
IF (BCOUNT.GT.1) GO TO 301
CALL TARG2
CALL BCCMPA
CALL BCCMPB
CALL BCCMPC
CALL BCCMPD
CALL BCCMPE
CALL BCCMPF
CALL BCCMPG
CALL BCCMPH
CALL BCCMPI
CALL BCCMPJ
CALL BCCMPK
CALL TARG3
IF (BCOUNT.LT.14) GO TO 300
CALL TARG4
CONTINUE
STOP
END

```

700
200

201

300

301

1000

MAI000440
MAI000450


```

SLBRoutine TARGI
THIS SUBTCUTIME FREEZES OR HOLD CONSOLE INPUTS FOR 1/2 SECOND
AND CALCULATES OR DETERMINES THE FOLLOWING INDICATORS;AA
BALLISTICS,CARTESIAN BALLISTICS,AMMOTYPE,CHARGE,GUN AND
GUN CONTROL CONSOLE ASSIGNMENTS,TARGET ASSIGNMENTS, IN
BALLISTICS CODE, ACQUISITION OR TRACKING ASSIGNMENTS. IN
ADDITION,TARGI COMPUTES BALLISTICS PARAMETERS THAT
MAY EXIST IN VARIOUS BALLISTICS PARAMETERS, PERFECTICNS, A SHIP'S
COURSE UPDATE, AND DETERMINES GUN PARALLAX THE TARGET DATA FOR THE
CALCULATIONS ARE ALSO PERFORMED TO UPDATE THE TARGET INTEGER 1/4
VARIOUS BALLISTICS MODES TO BALLISTICS TIME ,NEXT INTEGER 1/4
SECOND
COMMON/RT/COGSI,SINI,TAN
COMMON/N2/BCOUNT
COMMON/T121/EI,BYL
COMMON/T120/IH,IPT,ITF,IU,IWT,HC,UO
COMMON/T119/TB,TBR
COMMON/T118/AARO,RNGDOT,RC
COMMON/T117/BALLI,NEW3DT,NOCLOS,AQUIRE,ICCLNT,KGOOD,BALINC
COMMON/T116/DSU,DTF,DWT,PWDTMP,DH
COMMON/T1151/ZSUBN(3),CDMRIZ(3)
COMMON/T124/QALS,QAK2,QAV,ERVG,QR3,QRLR,QVR,PV
COMMON/T113/WX,WY,WXR,WYR
COMMON/T112/SINLAT,COGSLAT,CQG,DCQG,SINLAR,CCSLAR
COMMON/T11/ROX,ROY,DMCX,DMCY,ROXY,RCYY,RXL,RYL,RZL,DMOXY,CMOYY,
CDRTX,DRTY,DRTZ
COMMON/OZ/RHGEN,RZGEN
REAL*4 LCGO
REAL*4 ITB
REAL*4 KPT
REAL*4 JOELCK
GUNASS=1
INDICATE AA MODE
GUNIBI=7
GUNIR=GUNASS
GUNIBR=GUNIBI
COMPUTE CHANGE IN PROJECTILE VELOCITY DUE TC CHANGE INPOWDER
TEMPATURE
IPT=PWDTMP-90

```


CC	SAVE SINE AND COSINE OF SHIP'S LATITUDE FCR 1/2 SECOND	TAR00420
	SINLAR=SINLAT	
	CCSLAR=COSLAT	
CC	SAVE TARGET'S HEIGHT FOR 1/2 SECOND	TAR00450
	RV=ERVG	
CC	INDICATE LOW ANGLE FIRE	TAR00470
	HABIR=0	
CC	INDICATE STANDARD CHARGE	TAR00490
	STADIR=0	
CC	INDICATE CVT FUZE	TAR00510
CC	INDICATE CVT FUZE	TAR00300
	CVTMT=0	
CC	INDICATES VT AMMO	TAR00530
	AMMOR=3	
	PFINO=0	
	GRID=0	
	NCCLOS=0	
CC	CHECK FCR INCOMING OR OUTBOUND TARGET	TAR00580
CC	IF OUTBOUND AND RANGE GREATER THAN 50K YARDS NO SOLUTION	TAR00590
	IF(RNGDOT.LT.0)GO TO 1	
	IF(AARO-50000.GT.0) GO TO 2	
CC	IF INCOMING AND RANGE GREATER THAN AL NO SOLUTION	TAR00620
	AL=32000-65*RNGDOT*21.85	
	RNGI=AARO-AL	
	IF(RNGI.GT.0.0) GO TO 2	
	NCCDEM=3	
CC	COMPUTE DIFFERENCE IN AIR TEMPERATURE	TAR00670
	ITF=DTF-59	
CC	CCMUTE DIFFERENCE IN AIR DENSITY	TAR00690
	HO=DH	

EQDENS=C.0 IH=HO-100+EQDENS KPT=1.2 IUP=KPT*IPT	TAR00750
SAVE WIND COMPONENTS' FOR 1/2 SEC	
WYR=WY WXR=WX	
CCOMPUTE DIFFERENCE IN PROJECTILE WEIGHT	TAR00780
IWT=DWT-72 AMNCTR=0	
SAVE OBSERVED PROJECTILE VELOCITY	TAR00810
UC=DSU	
COMPUTE CHANGE IN PROJECTILE VELOCITY	TAR00830
IU=UG-2500+IUP AMMOSH=0	
BALLISTIIC TIME NOTE TBR,TB,TC, VALUES ARE ASSUMPTIONS	TAR00860
TBR=0 TB=1.0/4.0 TC=1.0/8.0	
CCOMPUTE SHIP'S UPDATED HEADING	TAR00900
LC6C=CQC/57.293+(TB-TC)*DCQC/57.293	
NOTE CQO AND DCQO CONVERTED TO RADIAN	TAR00920
SNLCQC=SIN(LCQO) CSLCQO=COS(LCQO) PCA=0.0 PCQ=0 PVC=0	
PCC,PDA,PVD ARE THE PARALLAX ARMS COMPUTE STATIC GUN PARALLAX	TAR00980 TAR00990
PXL=PDA*CSLCQO+PDO*SNLCQO PYL=PDO*CSLCQO-PDA*SNLCQO	

C	UPDATE OWNERSHIP'S POSITION AND REATES TO BALLISTIC TIME	TAR01020
C	RCXY=ROX+DMOXY*1/4	
	CMCY=DMOY	
	RCYY=ROY+DMOYY/4	
C	ICOUNT=0 INDICATES FIRST PASS FOR TARG3 PROGRAM	TAR01060
C	ICCOUNT=0	
	CR3=QAR2	
	QALR=QALS	
	QVR=QAV	
C	CR3, QRLR, QVR ARE SPOTS FOR AA	TAR01110
C	JOELCK=-1.0/32.0	
C	JOELCK=-1/32 AN ASSUMPTION	TAR01130
C	ITB=TB-JOELCK	
C	COMPUTE TARGET POSITION AND RATES UPDATED TC BALLISTIC TIME	TAR01150
	RTZL=ZSUBN(1)+CDMRTZ(1)*ITB	
	DRTZ=CDMRTZ(1)	
	RTXL=ZSUBN(2)+CDMRTZ(2)*ITB	
	DRTX=CDMRTZ(2)	
	RTYL=ZSUBN(3)+CDMRTZ(3)*ITB	
	DRTY=CDMRTZ(3)	
	WRITE(6,700) RTZL,RTXL,RTYL	
	FCRMT(10X,3E15.8)	
700		
C	NO PREVIOUS BALLISTIC SOLUTION	TAR01220
C	CCOMPUTE RELATIVE TARGET POSITION AT POINT 1	TAR01230
	RYL=RTYL-RCYY-PYL	
	RXL=RTXL-RCXY-PXL	
	WRITE(6,701) RCYY,RCXY,PYL,PXL	
200	FORMAT(10X,4E15.8)	
701	Y1=RYL**2	
	Y2=RXL**2	
	RH1=SQRT(Y1+Y2)	
	BYL=0	
	SINI=RYL	
	CS1=RXL	
	CALL ARTAN	
	BYL=TAN	
	RZ3=RTZL-PVD	

	RHGEN=RH1		
	RZGEN=RZ3		
	CALL ZLIMIT		
	RZL=RZGEN		
C	CCMPUTE SLANT RANGE TO POINT 1 (RC)		TAR01390
C	Y3=RH1**2		
	Y4=RZL**2		
	WRITE(6,700) RZL,RTXL,RTYL		
	WRITE(6,700) RZL,RXL,RYL		
	RC=SQRT(Y3+Y4)		
	SNBYL=RZL/RC		
	E1=AR SIN(SNBYL)*57.293		
	IF(E1-85.GT.0) E1=85		
	WRITE(6,803) NEW3DT		
803	FCR MAT(10X,'NEW3DT=',I5)		
	WRITE(6,801) BALL1		
801	FCR MAT(10X,'BALL1=',E15.8)		
C	CHECK FOR NEW TARGET INDICATION(NEWGT GREATER THAN ZERC)		TAR01460
C	NEW3DT=0		
C	IF(NEW3DT)20,20,21		
C	CHECK FOR BALLISTIC SOLUTION		TAR01480
C	IF(BALL1)22,22,21		
20	GCDD BALLISTIC SOLUTION SYSTEM IN TRACK MCDE NEXT PROGRAM CALLED		TAR01500
C	IS TARG3		TAR01510
C			
22	ACQUIRE=0		
	BCCUNT=13		
	WRITE(6,800) BCCUNT		
800	FORMAT(10X,'BCCUNT=',E15.8)		
	RC		
500	WRITE(6,500) RC		
	FCR MAT(10X,'RC=',E15.8)		
	E1		
501	WRITE(6,501) E1		
	FCR MAT(10X,'E1=',E15.8)		
	ITB		
502	WRITE(6,502) ITB		
	FORMAT(10X,'ITB=',E15.8)		
	BYL		
503	WRITE(6,503) BYL		
	FORMAT(10X,'BYL=',E15.8)		
	RXL,RYL,RZL		
600	WRITE(6,600) RXL,RYL,RZL		
	FCR MAT(10X,3E15.8)		
	RETURN		
21	NEW3DT=1		

C
C
C

NC BALLISTIC SOLUTION NEXT PROGRAM CALLED IS TARG2

TAR01640
TAR00020

```
BCCOUNT=1
FSTBAL=1
WRITE(6,803) NEW3DT
WRITE(6,800) BCCOUNT
WRITE(6,500) RC
WRITE(6,501) E1
WRITE(6,503) BYL
WRITE(6,502) ITB
RETURN
BALI=1
BCCOUNT=0
RETURN
END
```

2

C
C
C
C
C
C
C
C
C
C

SLBROUTINE TARG2
THIS SUBROUTINE PERFORMS THE ACQUISITION BALLISTICS COMPUTATIONS

THIS SUBROUTINE PERFORMS THE ACQUISITION BALLISTICS COMPUTATIONS
FOR AA IN CARTESIAN BALLISTICS. ITS FUNCTION IS TO CALCULATE POINT
3, THE THEORETICAL AIMING POINT, FROM POINT 1, THE TARGET POSITION
AT BALLISTICS TIME. THIS SUBROUTINE DETERMINES THE FIRST ADVANCE
PC SITUATION WHEN NO VALID PRIOR ADVANCE POSITION EXISTS. THIS
SITUATION WOULD OCCUR WHENEVER A NEW AA TARGET HAS BEEN ASSIGNED
THERE WAS NO BALLISTICS SOLUTION DURING THE PREVIOUS 1/2 SECCND.

TAR00150
TAR00160
TAR00170
TAR00180
TAR00190
TAR00200
TAR00210
TAR00220

```
CCMMON/RT/COS1,SIN1,TAN
CCMMON/T121/E1,BYL
CCMMON/T13/AARO,RNGDOT,RC
CCMMON/T1/ROX,ROY,DMOX,DMCY,ROXY,PCYY,RXL,RYL,RZL,DMCXY,DMOYY,
CDRTX,DRTY,DRTZ
CCMMON/T120/IH,IPT,ITF,IU,IWT,HC,UC
CCMMON/N1/ICODDP,DPDEP,TEMP2,TMP3,TMP10
CCMMON/T21/RTMP,R3,RX3,RY3,RHOLD
CCMMON/T22/E3,SINE3,COS3,BY3,SINBY3,COSBY3
CCMMON/T17/BALL1,NEW3DT,NOCLOS,ACQUIRE,ICOUNT,KGOOD,BALIND
CCMMON/N2/BCCOUNT
CCMMON/CZ/RHGEN,RZGEN
```

C
C
C
C

SILFLG=0
INDICATES IN ACQUISITION MODE
ACQUIRE=1
INDICATES MORE THAN ONE ACQUISITION IS REQUIRED BEFORE GUN IS RELEASED
CCMPUTE TIME OF FLIGHT TO POINT 1
RTMP=RC

TAR00250
TAR00270
TAR00290


```

RX11=T11*DRTX+RXL
RY11=T11*DRTY+RYL
RZ11=T11*DRTZ+RZL
RH11=RX11**2+RY11**2
RHGEN=RH11
RZGEN=RZ11
CALL ZLIMIT
RZ11=RZGEN**2+RZ11**2
R11=SGT(R11)
CCPUTE BEARING ELEVATION, RANGE VALUES TC ADVANCED AIM POINT 3
CSINI=RY11/RH11
CCSL=RX11/RH11
CALL ARATAN
BY3=TAN
SINE3=RZ11/R11
IF(SINE3-0.99619.GT.0.0) E3=85/57.293
E3=AR SIN(SINE3)
CCSE3=CCS(E3)
E3=E3*57.293
TMP8=IH*0.005+1
XX=1-IU/UQ
XY=XX*TMP8
R3=XY*R11
SINBY3=SIN(BY3/57.293)
CCSBY3=CCS(BY3/57.293)
CCPUTE HORIZONTAL COMPONENTS OF ADVANCED RANGE
RX3=R3*CCSE3*SINBY3
RY3=R3*CCSE3*CCSBY3
BCCUNT=2
WRITE(6,804) T1,T11,U4
FCR MAT(10X,3E15.8)
WRITE(6,500) R3
FORMAT(10X,'R3=',E15.8)
WRITE(6,501) E3
FORMAT(10X,'E3=',E15.8)
WRITE(6,502) BY3
FCR MAT(10X,'BY3=',E15.8)
END

```

C

C

804
500
501
502

```

SUBROUTINE BCOMPA
C
C THIS SUBROUTINE COMPUTES THE TIME OF FLIGHT TO POINT 3(T3), AND
C THE DERIVATIVES OF T3 WITH RESPECT TO RANGE(DT3DR), ELEVATION(DT3DE)
C AND THE MIXED PARTIAL(DT3RDE).
BC0000010
BC0000020
BC0000030
BC0000040
BC0000050

```


BC0000060
BC0000130

C

```
COMMON/CA/T3,DT3DR,DT3DE,DT3RDE
COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
COMMON/N2/BCOUNT
COMMON/T21/RTEMP,R3,RX3,RY3,RHOLD
COMMON/A1/KORIND,STACK(11),HOLDB3(3),PRTET,IR3,EXACTE,B6,
CDPDE,ISRCH
INTEGER*4 T17
```

C

GAR000340
TAR000230

KCRIND IS THE NUMBER OF COEFFICIENTS PER RANGE INTERVAL

```
KORIND=4
ICCODEP=1
TMP3=1
RTEMP=R3
CALL TMCNIT
T3=TEMP2
DT3DR=TMP10
DT3DE=DPDEP
DT3RDE=DPDED
BCCOUNT=3
WRITE(6,100)T3
FORMAT(10X,'T3=',E15.8)
WRITE(6,101)DT3DR
FORMAT(10X,'DT3DR=',E15.8)
WRITE(6,102)DT3DE
FORMAT(10X,'DT3DE=',E15.8)
WRITE(6,103)DT3RDE
FORMAT(10X,'DT3RDE=',E15.8)
RETURN
END
```

100
101
102
103

BC0000030
BC0000040
BC0000050
BC0000060
BC0000070
BC0000080
BC0000090
BC0000100
BC0000110
BC0000120
BC0000130
BC0000140
BC0000150
BC0000160
BC0000170
BC0000180
BC0000190
BC0000200
BC0000210
BC0000220

SUBROUTINE BCOMPB

THIS SUBROUTINE FINDS THE SUPERELEVATION ANGLE(EGB), THE VALUE IS
RETURNED IN TEMP2 IN MINUTES SO MUST BE CHANGED TO DEGREES. THE
DERIVATIVE WITH RESPECT TO RANGE, (DEGR), RETURNED IN TMP10, THE
THE DERIVATIVE WITH RESPECT TO ELEVATION (DEGDE) IN DPDEP, THE
MIXED PARTIAL (DEGRDE) IN DPDED

C
C
C
C
C
C

BC0000020
BC0000030
BC0000040
BC0000050
BC0000060
BC0000070
BC0000080

```
COMMON/T22/E3,SINE3,COSE3,BY3,SINBY3,COSBY3
COMMON/N2/BCOUNT
COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
COMMON/C3/COS E4,DEGDE,DEGR,EGB1,E4,SINE4,DEGRDE
```

C

BC0000130
BC0000060
BC0000070

```
TMP3=1
ICCODEP=2
```


BCC000080
BCC000090
BCC000100
BCC000110
BCC000120
BCC000130
BCC000140
BCC000150
BCC000160
BCC000170
BCC000180
BCC000190
BCC000200
BCC000210
BCC000220
BCC000230
BCC000240
BCC000250
BCC000260
BCC000270
BCC000280
BCC000290
BCC000300
BCC000310
BCC000320

```

CALL TMCNIT
EGB=TEMP2/60
E4=E3+EGB1 E3 AND EGB
IF(E4-85)1,2,2
  E4=85
  E41=E4/57.293
  SINE4=SIN(E41)
  CCSE4=CCS(E41)
  DEGR=TMP10
  DEGRDE=DPDEP
  DEGRDE=CPDED
  BCCUNT=4
  WRITE(6,100)EGB1
  FORMAT(10X,'EGB1=',E15.8)
  WRITE(6,101)E4
  FORMAT(10X,'E4=',E15.8)
  WRITE(6,102)DEGR
  FORMAT(10X,'DEGR=',E15.8)
  WRITE(6,103)DEGRDE
  FORMAT(10X,'DEGRDE=',E15.8)
  WRITE(6,104)DEGRDE
  FORMAT(10X,'DEGRDE=',E15.8)
  RETURN
END

```

C

2
1

100

101

102

103

104

BCC000010
BCC000020
BCC000030
BCC000040
BCC000050
BCC000060
BCC000070

```

SUBROUTINE BCOMP
THIS SUBROUTINE COMPUTES THE DERIVATIVE OF RANGE WITH RESPECT TO
TC NON-NOMINAL INCREMENTS OF PROJECTAL VELOCITY (DRDU) AND
THE DERIVATIVES OF DRDU WITH RESPECT TO ELEVATION (DRDUDE). IT ALSO
COMPUTES THE ACTUAL RANGE EFFECT (URH) DUE TO DRDU

```

C
C
C
C
C

```

COMMON/T120/IH,IPT,ITF,IU,IWT,HC,UC
COMMON/N2/BCCUNT
COMMON/N1/ICODEP,DPDED,TEMP2,TMP3,TMP10
COMMON/OC/DRDU,DRDUDE,URH

```

BCC000120
BCC000070
BCC000080
BCC000090
BCC000100
BCC000110
BCC000120
BCC000130

```

TMP3=0
ICODEP=3
CALL TMCNIT
DRDU=TEMP2
URH=DRDU*IU
DRDUDE=DPDED
BCCUNT=5
WRITE(6,100)DRDU

```

C

00000
145678
11111
00000
00000
00000
00000

```
100 FFORMAT(10X,'DRDU=',E15.8)
      WRITE(6,101)DRUDE
101 FFORMAT(10X,'DRUDE=',E15.8)
      RETURN
      END
```

BC00010
C0M0010
C0M0020
C0M0030
C0M0040
C0M0050

THEY ALSO INCREASED THE TIME OF FLIGHT WITH THE PROJECTILE RANGE (DT3JDR) AND THE INCREASING OF ELEVATION CR RANGE (DT3JDR).

ELEVATION OR RANGE (T/DT3UDE,DT3UCR)
 COMMON/T120/IH,IPT,ITF,IU,IWT,HO,UO
 COMMON/N2/BCOUNT
 COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,T
 COMMON/CO/DT3DU,DT3UDR,DT3UCE,UT3

BC000070
BC000080
BC000090
BC000110
BC000120
BC000130
BC000140

```
TVP3=1  
TICCDP=4  
ICALL TMCNIT  
DT3UDR=TMPI10  
CT3DU=TEMP2  
UT3=DT3DU*IU  
CT3UDE=OPDEP  
BCUTE(6,100)  
WRITER(6,100) DT3UDR=' ,E15.8)  
FORWRI(6,101) DT3DU  
FORWRI(6,101) DT3DU=' ,E15.8)  
FORWRI(6,102) UT3  
FCRMI(6,102) UT3=' ,E15.8)  
WRWR(6,103) DT3UDE  
FCRMI(6,103) DT3UDE=' ,E15.8)  
RETURN  
END
```

[illegible]

SLBROUTINE BCGMPE COMPUTES THE DERIVATIVE CF RANGE WITH RESPECT TO THIS SUBROUTINE COMMENTS IN AIR DENSITY (DRDH) AND THE DERIVATIVE OF CF DRDH WITH RESPECT TO ELEVATION (DRDHE). IT ALSO COMPUTES THE ACTUAL RANGE EFFECT DUE TO NON-NOMINAL BALLISTIC DENSITY (HRH).

B	C	C	C	C
G	M	M	M	M
O	O	O	O	O
I	L	S	T	U

COMMON/TL20/IH, IPT, ITF, IU, IWT, HC, LC
COMMON/N2/BCOUNT


```
COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
COMMON/CE/DRDH,DRDHCE,HRH
```

```
POWER=0
TMP3=0
ICODEP=5
CALL TMCNIT
DRDH=TEMP2
HRH=DRDH*IH
LRCHDE=DPDEP
BCCUNT=7
WRITE(6,100)DRDH
FCRMA(10X,DRDH=',E15.8)
100 WRITE(6,101)HRH
101 FCRMA(10X,HRH=',E15.8)
102 WRITE(6,102)DRDHDE
FCRMA(10X,DRDHDE=',E15.8)
RETURN
END
```

```
BCC000070
BCC000080
BCC000090
BCC000100
BCC000110
BCC000120
BCC000130
BCC000140
BCC000150
BCC000160
BCC000170
BCC000180
BCC000190
BCC000200
BCC000210
BCC000220
```

```
SUBROUTINE BCOMPF
THIS SUBROUTINE COMPUTES THE DERIVATIVE OF TIME OF FLIGHT WITH
RESPECT TO NON-NOMINAL INCREMENT IN AIR DENSITY (DT3DH),AND
CCOMPUTES THE ACTUAL TIME OF FLIGHT EFFECT (FT3) DUE TO DT3DH.
```

```
BCC000010
CCM000110
CCM000120
CCM000130
CCM000140
```

```
COMMON/T120/IH,IPT,ITF,IU,IWT,HO,UO
COMMON/N2/BCCUNT
COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
COMMON/CF/HT3,DT3DH,DT3HDE,DT3HDR
```

```
POWER=0
TMP3=1
ICODEP=6
CALL TMCNIT
DT3HDE=TEMP10
DT3DH=TEMP2
HT3=DT3DH*IH
LRCHDE=DPDEP
BCCUNT=8
WRITE(6,100)DT3HDR
FCRMA(10X,DT3HDR=',E15.8)
100 WRITE(6,101)DT3DH
101 FCRMA(10X,DT3DH=',E15.8)
102 WRITE(6,102)HT3
WRITE(6,103)HT3=',E15.8)
103 FCRMA(10X,DT3HDE=',E15.8)
```

```
BCC000070
BCC000080
BCC000090
BCC000100
BCC000110
BCC000120
BCC000130
BCC000140
BCC000150
BCC000160
BCC000170
BCC000180
BCC000190
BCC000200
BCC000210
BCC000220
```


BC000240
BC000250

RETURN
END

BCJ00C10
TQ A
CQM00150
CQM00160
CQM00170
CQM00180

SUBROUTINE BCMPG COMPUTES THE DERIVATIVE OF THE RANGE WITH RESPECT TO A SUBROUTINE INCREMENT IN SURFACE AIR TEMPERATURE (ORDTF) THE NON-NOMINAL INCREMENT IN SURFACE AIR TEMPERATURE OF RANGE WITH ACTUAL RANGE EFFECT (TFR3), AND THE MIXED PARTIAL OF RANGE WITH RESPECT TO TEMPERATURE AND ELEVATION (DRTFCE).

COMMON/CG/DRTFDE,DRDIF,TR3
COMMON/NL/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
COMMON/N2/BCOUNT
COMMON/T120/IH,IPT,ITF,IU,IWT,HC,UC

[illegible]

```

TMP3=0
I CODEP=7
CALL TMONIT
DRDTF=TEMP2
ITFR3=ITF
CRITFDE=DPDEP
BCCOUNT=$
WWRITTE(6,100)DRDTF
FORMAT(10X,'DRDTF=',E15.8)
WWRITTE(6,101)ITFR3
FORMAT(10X,'ITFR3=',E15.8)
WWRITTE(6,102)DRITFDE
FORMAT(10X,'DRITFDE=',E15.8)
RETURN
END

```

[illegible]

SUBROUTINE BCORPH COMPUTES THE DERIVATIVE OF T3 WITH RESPECT TO A H
THIS SUBROUTINE INCREASES THE SURFACE TEMPERATURE, COMPUTES THE
NON-NOMINAL FLIGHT EFFECT (TIME OF FLIGHT), PERFORMS PARTIAL SUMMATION OF ALL THE
EFFECTS OF SUBROUTINE BCORPH, AND CALCULATES THE FLIGHT TIME OF SCINT2,
AND THE PREDICTED IMPACT POINT WITH RESPECT TO RANGE (DI2DR)

CCOMON/CA/T3,DT3DR,DEDE,DT3RDE
CCOMON/CB/CQSE4,DEGDE,URH3DR,EGB1,E4,SINE4,CEGRDE
CCOMON/CC/DRDU,DRDUDE,URH3DR,UT3
CCOMON/CD/DT3DU,DT3UDE,UT3
CCOMON/CE/DRDH,DRDH,DT3FDE,DT3HDR
CCOMON/CF/HT3,DT3DH,DT3FDE,DT3FDR
CCOMON/CG/DRTFDE,DRTF,TFR3


```

COMMON/T21/RTEMP,R3,RX3,RY3,RHOLD
COMMON/T120/IH,IPT,ITF,IU,IWT,HO,UO
COMMON/N2/BCOUNT
COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
COMMON/CH/TFT3,DT3FDE,JLR3,R2J1,WTR3,WTJ3,T2J1,DT2DR
C,DT3DTF

```

C

```

PCWDT=0
PCWDR=0
TMP3=0

```

```

ICCODEP=8
CALL TMCNIT
DT3DTF=TEMP2
TFT3=DT3DTF*ITF
DT3FDE=DPDEP
CALL RTEWT

```

```

C COMPUTE FIRST PARTIAL SUM OF RANGE EFFECTS WITHOUT R3
JLR3=WTR3+URH+HRH+IFR3+POWDR
C COMPUTE FIRST PARTIAL SUM OF TIME OF FLIGHT WITH T3
R2J1=JLR3+R3
C COMPUTE FIRST PARTIAL SUM OF TIME CF FLIGHT WITH T3
T2J1=WTR3+UT3+HT3+TFT3+POWDT+T3
C COMPUTE DERIVATIVE CF TIME CF FLIGHT TO PCINT 2 WITH
RESPECT TO RANGE
DT2DR=DT3DR+DT3HDR*IH+DT3UDR*IU
BCCUNT=10

```

101

102

100

```

WRITE(6,101)TFT3
FORMAT(10X,'TFT3=',E15.8)
WRITE(6,102)DT3FDE
FORMAT(10X,'DT3FDE=',E15.8)
WRITE(6,100)DT3DTF
FORMAT(10X,'DT3DTF=',E15.8)
RETURN
END

```

```

SUBROUTINE BCOMPI
THIS SUBROUTINE COMPUTES THE DOWNRANGE AND CROSSRANGE COMPONENTS
OF GUN MOTION (DMR3OG AND DMBOG) BEFORE CALLING GUNMCT. IT THEN
COMPUTES THE TANGENT CF ANGLE OF FALL (TANW) BEFORE CALLING
THE WIND ECCECTS(WIND) SUBROUTINE

```

```

COMMON/T1/ROX,ROY,DMCX,DMOY,ROXY,ROYL,RXL,RZL,DMCXY,DMCYY,
CDRTX,DRTY,DRIZ
COMMON/T22/E3,SINE3,COSE3,BY3,SINBY3,COSBY3
COMMON/CB/COSE4,DEGCE,DEGDR,EG81,E4,SINE4,DEGRDE
COMMON/T21/RTEMP,R3,RX3,RY3,RHOLD
COMMON/N1/ICODEP,DPDEP,CPDED,TEMP2,TMP3,TMP10

```

```

BCC000G50
BCC000G60
BCC000G70
BCC000G80
BCC000G90
BCC000I00
BCC000I10

```

```

BCC000I20
CCM000270
BCC000I30

```

```

COM000280
COM000290
BCC000I50
BCC000I60
BCC000I90
BCC000200
BCC000210
BCC000220
BCC000I70
BCC000I80
BCC000200
BCC000210

```

```

BCC000010
COM000310
COM000320
COM000330
COM000340
COM000350

```


COMMON/I/ANGLEW,DMR30G,DMBOG,SINEGB,COSEGB,TANEG, CTANW,TOVERW CCOMMON/CH/TFT3,DT3FDE,J1R3,R2J1,WTR3,WT3,T2J1,DT2DR C,CT3DTF CCOMMON/N2/BCOUNT	CGM00300 BC000040 BC000050 BCC00070 BCC00080 COM00360 COM00370 BCC00090 BCC00100 BCC00110 BCC00120 BCC00140 BCC00150 BCC00160 BCC00170 BCC00180 BCC00190 BCC00200 BCC00210 BCC00220 BCC00230 BCC00240 BCC00250 BCC00260
CCOMPUTE DOWNRANGE COMPONENT OF GUN MOTION DMR30G=DMOXY*SINBY3+DMOYY*CCSBY3 CCOMPUTE CROSSRANGE COMPONENT OF GUMMOTION CMBOG=DMOXY*CCSBY3-DMCYY*SINBY3 SINEGB=SIN(EG81/57.293) COSEGB=COS(EG81/57.293) CALL GUNMOT TMP3=0	
RANGE IS SET EQUAL TO FIRST PARTIAL SUM OF RANGE EFFECTS BEFORE TMCNIT IS CALLED RTEMP=R2J1 ICCDEP=9 CALL TMCNIT ANGLEW=TEMP2 CCOMPUTE TANGENT OF GUN ELEVATION (TANEG) MUST CHECK FOR INFINITY IF(COSEGB.EQ.0) TANEG=500000000 TANEG=SINEGB/COSEGB CCOMPUTE TANGENT OF ANGLE OF FALL(TANW) TANW=TANEG*ANGLEW IF(TANW.GT.10000) TOVERW=0 TCOVERW=T2J1/TANW IF(TOVERW.GT.100000) TOVERW=10000 CALL WIND BCCUNT=11 WRITE(6,100)ANGLEW FCRMT(10X,'E15.8') WRITE(6,101)TCOVERW FCRMT(10X,'E15.8') RETURN END	COM00390 COM00400 COM00410 COM00420
SUBROUTINE BCOMPJ THIS SUBROUTINE OBTAINS A FIRST PARTIAL SUM OF RANGE EFFECTS AND A SECCND PARTIAL SUM OF TIME OF FLIGHT EFFECTS AND CALLS CORLIS TO OBTAIN COROILIS EFFECTS	
CCOMMON/N2/BCCOUNT CCOMMON/T21/RTEMP,R2,RX3,RX3,RY3,RHOLD CCOMMON/CW/DRDWRH,DT3CMY,WT3,WR3,WT3 CCOMMON/CGU/DRDMEY,DRDMEY,DT3CMY,WT3,WT3,WT3,WT3,WT3,WT3 CCOMMON/CH/TFT3,DT3FDE,J1R3,R2J1,WTR3,WT3,T2J1,DT2DR	


```

C      CCMPUTE VERTICAL RANGE EFFECTS TO POINT 2
BR2=J1R3+J2R3+KR3
BR3Q=BR3-QR3
RV2=(R3+BR3Q)*SINE3
WRITE(6,5C0) RV2,BR3Q
C      CCMPUTE HORIZONTAL RANGE TO IMPACT POINT 2
BRH3=BR3Q*COSE3
BRX3=BRH3*SINBY3+BRLS*COSEBY3
BRY3=BRH3*COSEBY3-BRLS*SINBY3
RY2=RY3+BR3
RX2=RX3+BR3
RH2=SQRT(RX2**2+RY2**2)
C      CCMPUTE SLANT RANGE TO IMPACT PCINT 2
R2=SQRT(RV2**2+RH2**2)
C      CCMPUTE BEARING TO IMPACT PCINT 2
CSIN1=RY2
CSL1=RX2
CALL ARCTAN
BY2=TAN
C      CCMPUTE ELEVATION TO IMPACT POINT 2
SINE2=RV2/R2
IF(SINE2-0.9962.GT.0.0) E2=85
E21=ARCSIN(SINE2)
E2=E21*57.293
BCCOUNT=13
WRITE(6,100) T2
FORMAT(10X,'T2=',E15.8)
100  WRITE(6,101) R2
101  FORMAT(10X,'R2=',E15.8)
102  WRITE(6,102) E2
102  FORMAT(10X,'E2=',E15.8)
103  WRITE(6,103) BY2
103  FORMAT(10X,'BT2=',E15.8)
105  WRITE(6,105) BRLS
105  FORMAT(10X,'BRLS=',E15.8)
500  WRITE(6,500) T2J2,KT3
500  FORMAT(10X,2E15.8)
      END

SUBROUTINE TARG3
THIS SUBROUTINE PERFORMS THE ITERATION AND CLOSURE COMPUTATIONS
FOR AA CATESIAN BALLISTICS. ITS FUNCDION IS TO UPDATE THROUGH
TWO ITERATIONS THE PREVIOUS AIM PCINT (3) SUCH THAT
SATISFACTORY COINCIDENCE IS OBTAINED BETWEEN THE PREDICTED IMPACT
PCINT (2) AND THE PREDICTED TARGET POSITION AT IMPACT TIME (21)
C      CCM00520
C      CCM00530
C      CCM00540
C      CCM00550
C      CCM00560
C      CCM00570

```

```

BC000080
BC000090
BC000100
CCM00510
BC000110
BC000120
BC000130
BC000140
BC000150
BC000160
BCC00170

```

```

BC000C190
BC000200
BC000210
BC000230
BC000240
BCC00260
BC000280

```

```

BCC00300
BCC00310

```

```

CCM00520
CCM00530
CCM00540
CCM00550
CCM00560
CCM00570

```



```

C THE CLOSURE EQUATIONS DETERMINE WHEN THERE IS SUFFICIENT CLOSENESS COM00580
C BETWEEN THE TWO POINTS FOR AN ACCEPTABLE SOLUTION. THE INPUT COM00590
C VALUES TO TARG3 COME FROM TWO SOURCES. IN THE TRACKING MODE COM00600
C THE DATA FROM THE PREVIOUS PASS THROUGH TARG3 TC BCCMPK IS COM00610
C USED TO UPDATE CURRENT VALUES. IN ACQUISITION MODE THE VALUES COM00620
C JUST CALCULATED IN TARG2 TO BCCMPK ARE USED COM00630
C COM00640

CCMMON/RT/COS1,SIN1,TAN
CCMMON/T21/RTMP,R3,RX3,RY3,RHOLD
CCMMON/T22/E3,SINE3,COSE3,BY3,SINBY3,COSBY3
CCMMCN/N2/BCOUNT
CCMMON/T31/BY22,IBY22,E22,R22,IT2
CCMMON/T3/RX21,RY21,DMRT21,DE21,DBY21,E21
CCMMON/OH/TF3,DT3FDE,J1R3,R2J1,WTR3,WTT3,T2J1,DT2DR
C DT3DTF
CCMMON/CA/T3,DT3DR,DT3DE,DT3RDE
CCMMON/CD/DT3DU,DT3UDR,CT3UDE,UT3
CCMMON/CF/HT3,DT3CH,CT3FDE,DT3HDR
CCMMON/T121/E1,BYL
CCMMON/T1/ROX,ROY,DMOX,DMOY,ROXY,RCYY,RXL,RYL,RZL,DMCXY,CMOYY,
CCRTX,DRTY,DRTZ
CCMMON/T120/IH,IPT,ITF,IU,IWT,HC,UC
CCMMON/T18/AARO,RNGDOT,RC
CCMMON/T17/BALL1,RNEW3DT,NOCLOS,ACQUIRE,ICCOUNT,KGOOD,BALIND
CCMMON/CK/R2,E2,T2,BY2
CCMMON/OZ/RHGEN,RZGEN

REAL*4 IR21
REAL*4 IT2,IT2X

C SILFLG=0
C CARTESIAN BALLISTIC
C CCMPUTE TARGET EASTING AND NORTHING COMPONENTS AT IMPACT TIME BY COM00650
C UPDATING COMPONENTS AT POINT 1 COM00660
RX21=DRTX*T2+RXL
RY21=DRTY*T2+RYL
X=RX21**2
Y=RY21**2
CCMPUTE HORIZONTAL RANGE TO TARGET AT IMPACT TIME
RH21=SQRT(X+Y)
CCMPUTE VERTICAL RANGE TO TARGET AT IMPACT TIME BY UPDATING PCINT 1
RHGEN=RH21
RZ21=RZL+T2*DRTZ
RZGEN=RZ21
CALL ZLIMIT
RZ21=RZGEN
X1=RZ21**2
Y1=RH21**2

```


C	1	R21=SQRT(X1+Y1)				
		IF(SINELG1)1,2				
		CCMPUTE SINEL AND COSINE OF BEARING TO TARGET POSITION				
		SNBY21=RX21/RH21				
C		CCMPUTE TARGET DOWNRANGE RATE DMRT21 AND TARGET CROSSRANGE				COM00670
C		RATE DMRT21				COM00680
		TMP=DRTX*SNBY21				
		DMRT21=DRTY*CSBY21				
		TMP1=DRTY*SNBY21				
		DMBT21=DRTX*CSBY21-TMP1				
C	2	CCMPUTE BEARING AND ELEVATION TO POINT 21 LIMIT ELEVATION TO 85				
		SIN1=RY21				
		CCS1=RX21				
		CALL ARATAN				
		BY21=TAN				
		X=RX21/R21				
		X1=X-0.9862				
		IF(X1)3,4				
		E21=85				
		GC TO				
	4	IN(X)*57.293				
	3	E21=ARCS				
C		CCMPUTE DIFFERENCE BETWEEN RANGE TO IMPACT POINT 21 AND TARGET				COM00690
C		RANGE AT IMPACT TIME				COM00700
	5	R21=RX21-R2				
		TMP=RX21*DRTX				
		TMP1=RY21*DRTY+TMP				
		TEMP2=DRTZ*RZ21				
		CCMPUTE TARGET RANGE RATE DMRT21				
C		DMRT21=(TEMP2+TMP1)/R21				
C		CCMPUTE TARGET HORIZONTAL RATE AL				
		AL=TMP1/RH21				
C		CCMPUTE TARGET VERTICAL RATE DRET21				
		AL1=AL*RZ21				
		AL2=RH21*DRTZ-AL1				
		DRET21=AL2/R21				
C		CCMPUTE DERIVATIVE OF IMPACT TIME WITH RESPECT TO ELEVATION DT2DE				
		DT2DE=DT3DE+IU*DT3UDE+IH*DT3HDE				
C		CCMPUTE MIXED PARTIAL WITH RESPECT TO RANGE AND ELEVATION DT2CRE				
		DT2RDE=(DT2DE*57.293)/R2				
		TMP1=DMRT21*DT2DR+TMP				
		DENOM=1-TMP1				
		TMP2=IR21*DT2DR				
		TMP3=IR21-E2				
		TMP4=TMP3*0.0174533				
		XNUMBER=TMP4*DT2RDE*R2+TMP2				
C		CCMPUTE IT2 TIME INCREMENT TO T2				


```

700 IT2=XNUMBER/DENOM
WRITE(6,700) DT2DR,DT2DE
WRITE(6,700) DT2RDE,TMP3
FORMAT(10X,2E15.8)
IT2X=ABS(IT2)
IF(IT2X1=IT2X-64
IF(IT2X1)11,12,12
IF(IT2)13,11,15
IT2=-64
GO TO 11
IT2=64
MUST LIMIT IT2 BETWEEN -64 AND +64 SEC. FIRST
THE ABSOLUTE VALUE OF IT2 IS SUB FROM 64 IF THE
RESULT IS POSITIVE A CHECK IS MADE ON SIGN OF IT2
IF(AQUICDE)21,21,22
IF(ACKMCDE)21,21,22
NOW LIMIT IT2 TO 4 OR - 8 SEC
IT2X2=IT2X-8
IF(IT2X2)22,24,24
IF(IT2)25,22,27
IT2=-8
GO TO 22
IT2=8
ACQUISITION MODE OR CONTINUE TRACK MODE R22
COMPUTE ESTIMATED INTERCEPT SLANT RANGE R22
R22=RT21+IT2*DMRT21
CARTESIAN BALLISTICS
TMP=IT2*DRRT21/R22
WRITE(6,700)IT2,IR21
TMP11=TMP*57.293
TMP12=ABS(TMP1)
TMP12=TMP11-45
IF(TMP12)41,42,42
IF(TMP1)43,41,44
TMP1=-41
GO TO 41
TMP1=45
ELEVATION TO PREDICTED INTERCEPT POINT
CCMPUTE E221+TMP1
E22=E221-85
IF(E22)51,52,52
IF(E22=85 E22+5
EEEE22=E22+53,53,54
IF(E22=-5
E22=-5
NOW E22 IS LIMITED BETWEEN -5 AND +85 DEGREES

```


54	SINE22=SIN(E22/57.293)	
	RH22=R22*SINE22	
	TMP=IT2*DMBT21	
	TMP1=TMP/RH22	
	TMP2=TMP1*57.293	
C	CCOMPUTE BEARING TO PREDICTED INTERCEPT PCINT	
	BY22=BY21+TMP2	
	RY221=BY22-360	
	IF(BY221/61,62,63	
62	BY22=0	
	GC TO 61	
63	BY22=BY22-360.0	
C	CHECK IF THIS IS THE FIRST OR SECCND PASS THRU TARG3	
61	IF(ICOUNT) 101,101,102	
C	FIRST PASS	
C	ADVANCE RANGE IS UPDATED BASED ON IMPACT PCINT 2 ANDESTIMATED	
C	INTERCEPT POINT 22	
101	R3=(R3*R22)/R2	
C	CCOMPUTE NEW ADVANCE BEARING BY3 AND ITS SINE AND COSINE	
	BY5=BY3+BY22-BY2	
	BY5=BY5-360	
	IF(BY5) 103,104,105	
104	BY3=0.0	
	GC TO 106	
105	BY3=360-BY5	
	GC TO 106	
103	BY3=BY5+360	
106	SINBY3=SIN(BY3/57.293)	
	CCSBY3=COS(BY3/57.293)	
C	CCOMPUTE NEW ADVANCE ELEVATION E3 AND ITS SINE AND COSINE	
	E7=E3-E2	
	IF(E7-30.GT.0) E7=30	
	IF(E7+30.LT.0) E7=-30	
	E3=E2+E7	
C	LIMIT E3 BETWEEN -5 AND 85	
	IF(E3-85.GT.0) E3=85	
	IF(E3+5.LT.0) E3=-5	
	SINE3=SIN(E3/57.293)	
	COS3=COS(E3/57.293)	
C	TEMP=R3*COSE3	
	CCOMPUTE HORIZONTAL COMPONENT OFADVANCE POSITION RX3 AND RY3	
	RX3=TEMP*SINBY3	
C	RY3=TEMP*CCSBY3	
	THIS PASS COMPLETED NEXT PROGRAM CALLED IS ECCMPA	
	ICOUNT=1	
	BCCOUNT=2	
	WRITE(6,100) RX21	
100	FCRMT(10X,'RX21=',E15.8)	

COM00710
COM00720


```

301 WRITE(6,301) RY21, RY21, E15.8)
302 FORMAT(10X, RY21, E15.8)
303 WRITE(6,303) RZ21, RZ21, E15.8)
304 FORMAT(10X, RZ21, E15.8)
305 WRITE(6,305) BY21, BY21, E15.8)
306 FORMAT(10X, BY21, E15.8)
307 WRITE(6,307) DMRT21, DMRT21, E15.8)
308 FORMAT(10X, DMRT21, E15.8)
309 WRITE(6,309) E22, E22, E15.8)
310 FORMAT(10X, E22, E15.8)
311 WRITE(6,311) R22, R22, E15.8)
312 FORMAT(10X, R22, E15.8)
313 WRITE(6,313) DRET21, DRET21, E15.8)
314 FORMAT(10X, DRET21, E15.8)
315 CHECK FOR CLOSURE
316 AL=IR21*NOCLOS-50
317 NOCLOS=0
318 CHECK IF RANGE LIMIT VIOLATED, VIOLATED IF AL GREATER THAN 0
319 IF(AL.GT.0) NOCLOS=AL
320 CHECK IF IT2 IS GREATER THAN IT2TST IF SC NC CLOSURE
321 IF(AQUIPE.GT.0) IT2TST=32
322 IT2TST=2
323 AL1=AL1-IT2TST
324 IF(AL2.GT.0) NOCLOS=AL2
325 CHECK IF INCOMING OR OUTBOUND TARGET, IF INCOMING CLOSURE IS GOOD
326 IF(DMRT21>201,201,202)
327 RETURN
328 AL3=DMRT21*DT2DR/2
329 CUTBOUND TARGET AND STILL CAN HIT IT GOOD CLOSURE
330 IF(AL3<1.0) RETURN
331 IF(IR21.LT.0) RETURN
332 IF(TARGET IS CUTBOUND AND IR21 IS + CANNOT HIT TARGET NC CLOSURE
333 NOCLOS=IR21
334 WRITE(6,800) NOCLOS
335 FORMAT(10X, NOCLOS, E15.8)
336 RETURN
337 SECOND PASS
338 COMPUTE DIFFERENCE IN R22 AND R2
339 IR22=R22-R2

```

COM00730


```

C      CCMPUTE DIFFERE CE IN BY22 AND BY2
C      IBY22=BY22-BY2
C      NEXT PROGRAM TO CALL IS TARG4
      WRITE(6,100) RX21
      WRITE(6,301) RY21
      WRITE(6,302) RZ21
      WRITE(6,303) R21
      WRITE(6,304) BY21
      WRITE(6,305) E21
      WRITE(6,306) DMRT21
      WRITE(6,307) DMRT21
      WRITE(6,108) E22
      WRITE(6,109) BY22
      WRITE(6,110) R22
      WRITE(6,111) DRET21
      BCCUNT=14
      GOTO 500
      END

```

```

SUBROUTINE TARG4
THIS SUBROUTINE COMPUTES THE BALLISTICS OUTPUTS FOR A
CARTESIAN BALLISTICS. IT COMPUTES THE FINAL INERTIAL GUN
ORDERS, GUN ORDER RATES, AND FUZE TIME RATE, AS WELL AS
THE INERTIAL IMPACT COORDINATES. THESE COMPUTATIONS ARE
ORIENTED TO THE NEXT 1/16 SECONC. TARG4 ALSO PROVIDES
TIME OF FLIGHT FOR DISPLAY ON GCC, CLOSURE CHECKS, AND
CCNTROL OF THE BALLISTICS SOLUTION LIGHTS ON THE GCC.

```

OPS00010

```

      COMMON/OH/TFT3,DT3FDE,JIR3,R2J1,WIR3,WTI3,T2J1,DT2DR
      DT3DTF
      COMMON/CB/COSE4,DEGDE,DEGDR,EGB1,E4,SINE4,DEGRDE
      COMMON/CK/R2,E2,T2,BY2
      COMMON/T19/TB,TBR
      COMMON/ODR/DORLS
      COMMON/T24/QALS,QAR2,QAV,ERVG,QR3,QRLR,QVR,RV
      COMMON/T1/ROX,ROY,DMCX,DMCY,ROXY,RCYY,RXL,RYL,RZL,CMOXY,DMOYY,
      CRTX,DRTY,DRIZ
      COMMON/T21/RTEMP,R3,RX3,RY3,RHOLD
      COMMON/T22/E3,SINE3,COSE3,BY3,SINBY3,COSBY3
      COMMON/T31/RX22,RY22,E22,R22,I12
      COMMON/T3/RX21,RY21,DMRT21,DE21,DBY21,E21
      COMMON/T17/BALL1,NEW3DT,NOCLOS,ACQUIRE,ICCLNT,KGOOD,BALIND
      COMMON/T14/BGYAUP,BTT2,DBGY,DEG,DT216,DT5,EGAUP,FLASH,LITSET,GE,QLS,TT2
      COMMON/N2/BCCOUNT
      REAL *4 IT2

```

KGCCD=0

OPS00020


```

C      FIRST A CHECK IS MADE TO DETERMINE IF CLCSURE HASOCCURED
C      IF (NOCLOS)1,1,2
C      CLCSURE HAS OCCURRED
C      IF (KGOOD)3,3,4
C      AL=0
C      GC TO 10
C      KGCCD=KGCCD-1
C      DT5=0
C      AL=1
C      GC TO 10
C      CLOSURE HAS NOT OCCURRED
C      IF (ACQUIRE)5,5,6
C      ACQUISITION MODE
C      BALL1=1
C      BCCUNT=0
C      RETURN
C      NO BALLISTIC SOLUTION (BALL1=1)
C      TRACK MODE
C      B2=1
C      AL=DMRT21+344.61
C      IF (AL.LT.0.0) GO TO 8
C      B2=B2-1
C      AL=DMRT21+84.41
C      IF (AL.LT.0.0) GO TO 8
C      B2=-1
C      B2=B2+1
C      AL=664
C      AL=AL/8
C      IF (B2.EQ.0.0) GO TO 4
C      B2=B2-1
C      GC TO 7
C      START OF TARG4 COMPUTATIONS
C      IF (AL.GT.0.0) GO TO 50
C      CCMPUTE SPOT VALUES IN MILS
C      GLS=GRLR
C      GE=GVR
C      CCMPUTE FINAL GUN ELEVATION(E4BT)
C      TEMP={R22-R2}
C      TEMP=TEMP*DEGDR
C      TEMP1=E22-E2
C      TEMP2=TEMP1*DEGDE
C      TEMP4=TEMP2+TEMP+E4
E4B=E4B+TEMP4+QE*0.05625
WRITE(6,700) TEMP,TEMP
WRITE(6,700) TEMP1,TEMP2
IF (E4B-85)11,12,12
E4BT=85

```



```

C      CCMPUTE UPDATED RANGE RATE (DR2)
C      DR2=DR22*(1+DT5)
C      CCMPUTE UPDATED GUN ELEVATION RATE(DEG)
      TMP12=DEGDR*DR2
      TMP13=TMP7*(1+DT5)
      TMP14=TMP13/TEMP14
      DEG=TMP12+TMP14
C      CCMPUTE UPDATED GUN BEARING RATE (DBGY)
      CBGY=DBGGY*(1+DT5)
      AL=E4BT-85
      IF(AL)31,32,32
32      DEG=0
31      TBFIN=15.0/32.0
      VALUE OF TBFIN IS ASSUMED
      DELTMP=TBFIN-TB
      WRITE(6,700) TB,TBFIN
C      CCMPUTE ADJUSTED TIME OF FLIGHT
      TT2=BT+T2+DELTMP*DT5
C      AA MODE, CALCULATE FINAL GUN ELEVATION ORDERS(EGAUP) AND
C      FINAL GUN BEARING CRDERS(BGYAUP)
      AL=DELTMP*DEG
      AL=AL+E4BT
      AL1=AL-85
      IF(AL1)41,42,42
42      EGAUP=85
      DEG=0
      GO TO 60
41      EGAUP=AL
60      BGYAUP=DELTMP*DBGY+BTBGY
      BGYAP=BGYAUP-360
      IF(BGYAP)71,72,73
73      BGYAUP=BGYAUP-360.0
      GO TO 71
72      BGYAUP=0.0
71      IF(T2-24.6)75,76,76
76      FLASH=200
      GC TO 77
75      LITSET=200
77      BALIND=1
50      BALI=0
      BCCUNT=C
      WRITE(6,100) DELTMP
100      FORMAT(10X,'DELTMP=',E15.8)
      WRITE(6,101) BT+T2
101      FORMAT(10X,'BT22=',E15.8)
      WRITE(6,102) E4BT
102      FORMAT(10X,'E4BT=',E15.8)

```



```

C      B8=0 INDICATES FIND THE HIGHEST STACK COEFFICIENTS
C      L=1  IS THE HIGHEST ELEVATION STACK
C      K1=K  IS THE ADDRESS OF FIRST COEFFICIENT
C      B5=HOLDB3(L)
C      CCMPUTE KGYP,DEYP,DBYP FOR EACH STACK THESE VALUES ARE STORED IN MATRIX KO
C      KCRTP(B6+3)=TABLE(ICODEP,K1,B5+1)*IR3+TABLE(ICODEP,K1,B5)
C      KCRTP(B6+2)=TABLE(ICODEP,K1,B5+3)*IR3+TABLE(ICODEP,K1,B5+2)
C      KCRTP(B6+1)=TABLE(ICODEP,K1,B5+5)*IR3+TABLE(ICODEP,K1,B5+4)
C      FIND LOWEST ELEVATION STACK COEFFICIENTS
C      WRITE(6,900) ICODEP,K1,B5
C      FCRMAT(10X,315)
C      L=L+1
C      K1=K-1
C      B6=3
C      IF(B8)1,1,2
C      GO TO 10
C      B6=0
C      INDICATES NORMAL LINEAR INTERPOLATION
C      WRITE(6,800) KORTP
C      FCRMAT(10X,E15.8)
C      STACK(1)=0
C      CCMPUTE CROSSRANGE EFFECOT OF CORIOLIS KBYP
C      STACK(6)=KCRTP(3)
C      STACK(7)=KCRTP(6)
C      CALL INTERP
C      KBYP=PRTE HORIZONTAL CORIOLIS EFFECT COEFFICIENT DEYP
C      CCMPUTE(6)=KCRTP(2)
C      STACK(7)=KCRTP(5)
C      CALL INTERP
C      KEYP=PRTE VERTICAL CORIOLIS EFFECT COEFFICIENT KGYP
C      CCMPUTE(6)=KCRTP(1)
C      STACK(7)=KCRTP(4)
C      CALL INTERP
C      KBYP=KBYP*XNEWOK
C      KEYP=KEYP*XNEWOK
C      KGYP=KGYP*XNEWOK
C      CCMPUTE CGRIOLIS EFFECT IN SLANT RANGE FCR CCNSTANT R3 KTR3
C      TMP=R2J2*SINBY3*CCSLAR
C      KYP=KGYP*KEYP
C      AL1=TMP*KEYP

```


C KTRR3 ELEVATION RATE FOR CONSTANT TIME OF FLIGHT KTRR3

C KTRR3 EFFECT ON TIME OF FLIGHT KT3
 C KTRR3 EFFECT ON ADVANCE RANGE R3 KR3
 C KTRR3 PARTIAL SUM OF TIME OF FLIGHT EFFECTS SQUARED
 C KTRR3 CORIOLIS EFFECT KRLS

4 3 700

AL2=AL1*SINE3
 AL3=AL2*COSE3
 KTRR3=AL3*T2J2
 COMPUTE3**2
 AL1=KYP*AL
 AL2=AL2*TMP
 KTRR3=AL3*T2J2/TANW
 COMPUTE CORIOLIS EFFECT ON TIME OF FLIGHT KT3
 KTRR3=KTRR3*DT3OR
 COMPUTE CORIOLIS EFFECT ON ADVANCE RANGE R3 KR3
 KTRR3=KTRR3+KTR3
 COMPUTE SECOND**2
 T2J2SQ=T2J2**2
 COMPUTE CROSSRANGE CORIOLIS EFFECT KRLS
 GK=3.574889
 TEMP=T2J2SQ*GK
 TANE4=SINE4/COSE4
 IF(TANE4-10000)3,4,4
 TANE4=10000
 AL=R2J2*TANE4
 WRITE(6,700) TANE4
 FCPRMAT(10X,E15.8)
 WRITE(6,700) TEMP
 WRITE(6,700) SINE4
 WRITE(6,700) COSE4
 AL1=AL*COSE3
 WRITE(6,700) AL1
 AL2=TEMP-AL1
 WRITE(6,700) AL2
 AL3=AL2*COSEY3
 WRITE(6,700) AL3
 TMP1=AL3*CCSLAR
 WRITE(6,700) TMP1
 WRITE(6,700) COSLAR
 AL4=R2J2*CCSE3
 WRITE(6,700) AL4
 AL5=AL4*SINLAR
 WRITE(6,700) AL5
 AL6=AL5+TMP1
 WRITE(6,700) AL6
 AL7=AL6*KYP
 WRITE(6,700) AL7
 WRITE(6,700) KYP
 WRITE(6,700) KEYP


```

WRITE(6,700) KBYP
KRLS=AL7*T2J2
WRITE(6,100) KT3,KRLS,KR3
FCRMAT(10X,3E15.8)
RETURN
END

```

100

```

SUBROUTINE DRIFT COMPUTES THE CROSSRANGE EFFECT OF PROJECTILE CRIFT
THIS SUBROUTINE DRIFT EFFECTS ARE COMPUTED BY DRIFT BECAUSE THE
THE BALLISTIC DRIFT EFFECTS ARE COMPUTED BY DRIFT BECAUSE THE
CURVE-FIT POLYNOMIAL FOR THE DRIFT EFFECT IS LINEAR AND DOES NOT
FIT THE NORMAL PATTERN THAT THE TABLE LOOKUP SUBROUTINES EXPECT
KORIND IS SET TO 2 TO INDICATE A NON-STANDARD TABLE. TWO POLY-
NOMIALS ARE NEEDED FOR THE AA MODE.

```

```

COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,IMP3,IMP10
COMMON/AL/KORIND,STACK(11),HOLDB3(3),PR1ET,IR3,EXACTE,B6,
CDEDE,ISRCH
COMMON/A2/TABLE(11,17,32),K,T17,LIMVIO
COMMON/CDR/DORLS
COMMON/CCR/KRLS,KR3,KTRRE3,KT3,T2J2SQ,TANE4
REAL*4 IR3
INTEGER*4 B5

```

C

```

TMP3=0
KCRIND=2
ICCODEP=11
CALL TMONIT
GET HIGEST STACK COEFFICIENTS FIRST
L=1
K1=K
B8=0

```

CC

```

ALLOCWS FOR TWO PASSES THRU STACKS
LOCATION OF FIRST COEFFICIENT
B5=HOLDB3(L)
STACK(6+88)=TABLE(ICODEP,K1,B5+1)*IR3+TABLE(ICODEP,K1,B5)
WRITE(6,102) STACK(6+88),IR3
WRITE(6,700) TABLE(ICODEP,K1,B5+1),TABLE(ICODEP,K1,B5)
FCRMAT(10X,2E15.8)
WRITE(6,701) ICODEP,K1,B5
FCRMAT(10X,3I5)
L=L+1
K1=K-1
IF(B8) 1,1,2
B8=1
GC TO 10
B6=0

```

C 10

700

701

1

2

OPS00120
OPS00130
OPS00140
OPS00150
OPS00160
OPS00170
OPS00180

OPS00190
OPS00200

```

C      NCRMAL LINEAR INTERPOLATION
C      CALL INTERP
C      CCMPUTE CROSSRANGE EFFECT ON PROJECTILE
C      DCRLS=PRITET*12J2SQ
C      WRITE(6,100) DORLS=,E15.8)
C      WRITE(6,101) PRITET,12J2SQ
C      WRITE(6,102) STACK(6),STACK(7)
C      RETURN
C      END

```

100
101
102

ZLI000C10
OPS00210
OPS00220
ZLI000030
ZLI000040
ZLI000050
ZLI000060

ZLI000070
ZLI000080
ZLI000090

ZLI000100
ZLI000110
ZLI000120
ZLI000130
ZLI000140
ZLI000150
ZLI000160

```

C      SUBROUTINE ZLIMIT
C      THIS SUBROUTINE LIMITS THE Z COORCINATE CF A TARGET TO A MINIMUM
C      BASED UPON TARGET HORIZONTAL RANGE,EARTH'S CURVATURE, HEIGHT CF
C      GUN ABOVE THE SEA SURFACE
C      COMMON/CZ/RHGEN,RZGEN
C      X=7.18E-08
C      AL=RHGEN*X
C      ALI=AL*RHGEN
C      PVD=14.43
C      RZS12=-AL-PVD-2
C      Y=RZGEN-RZS12
C      IF(Y)1,2,2
C      RETURN=RZS12+20
C      RETURN
C      END

```

2
1

```

C      SUBROUTINE RTWT
C      THIS SUBROUTINE IS CALLED FROM THE BCOMPH BALLISTICS SEGMENT AND
C      CALCULATES THE EFFECT ON TIME OF FLIGHT AND RANGE DUE TO PROJ-
C      ECTILE WEIGHT. A MINOR BUT OCCASIONALLY SIGNIFICANT EFFECT TO THE
C      THE NORMAL BALLISTIC SOLUTION IS THE EFFECT OF RANGE AND TCF
C      DUE TO A VARIATION IN SUM OF EQUIVALENT WEIGHTS OF INITIAL VELOCITIES CAN
C      BE CONSISTENT AS THE DENSITY. DUE TO INTERIOR BALLISTICS AN OPS00230
C      AND BASED ON AIRCRAFT WEIGHT WOULD BE EQUIVALENT TO A DECREASE IN OPS00240
C      INCREASE CF PROJ WHICH WOULD BE EQUIVALENT TO A DECREASE IN OPS00250
C      DENSITY THUS THE RANGE AND TIME COMPUTED AS THE SUM CF THE EQUIVA- OPS00260
C      JECTILE WEIGHT BARIATION CAN BE COMPUTED AS THE SUM CF THE EQUIVA- OPS00270
C      OPS00280
C      OPS00290
C      OPS00300
C      OPS00310
C      OPS00320
C      OPS00330
C      OPS00340

```


OPS00350
OPS00360

LENT EFFECTS ON INITIAL VELOCITY AND BALLISTIC AIR DENSITY

CCMMON/T120/IH,IPT,ITF,IU,IWT,HC,UC
CCMMON/OF/HT3,DT3DH,DT3HDE,DT3HCR
CCMMON/OD/DT3DU,DT2UDR,DT3UDE,UT3,DT3DR
CCMMON/CE/DRDH,DRDHDE,HRH
CCMMON/CC/DRDU,DRDUDE,URH
CCMMON/OH/TFT3,DT3FDE,JIR3,R2J1,WTR3,T2J1,DT2DR
C,DT3DTF

AMMOTR=0
CCMPUTE CHANGE IN RANGE DUE TO CHANGE IN PROJECTILE WEIGHT WTR3

TMP7=HO*DRDH
KWU=C*25980469

TMP71=UC*KWU
WTR31=IWT*(-1/70)

WTR3=(TMP71*DRDU+TMP7)*WTR31

CCMPUTE CHANGE IN TIME OF FLIGHT DUE TO CHANGE IN PROJECTILE WEIGHT WTT3

TMP74=HO*DT3DH
WTT3=(TMP71*DT3DU+TMP74)*WTR31

RETURN
END

OPS00370
OPS00380
OPS00390
OPS00400
OPS00410
OPS00420
OPS00430
OPS00440
OPS00450
OPS00460
OPS00470

SUBROUTINE GUNMOT IS CALLED FROM BCCMPI IN THE BASIC CALCULATION
THIS SUBROUTINE IS CALLED FROM BCCMPI IN THE BASIC CALCULATION
PART OF BALLISTICS. IT CALCULATES THE BALLISTICS EFFECTS DUE TO
GUN MOTION. SPECIFICALLY, THESE ARE THE EFFECTS ON ADVANCE RANGE
AND TIME OF FLIGHT AND THE DEFLECTION AND CROSSRANGE EFFECTS ON
GUN ORDERS. AS A BY-PRODUCT, THE GUN MOTION VECTOR INCREMENT TO
THE PROJECTILE VELOCITY IS OBTAINED UNDER CONDITIONS OF NO GUN
ACTION, THE PROJECTILE LEAVES THE MUZZLE WITH AN INITIAL VELOCITY
VECTOR (U) AT INERTIAL TRUE BEARING BYG, AND INERTIAL ELEVATION
ANGLE EG WITH GUN MOTION, THE COMPONENT ALONG THE U VECTOR (CUMOG)
WILL INCREASE THE MAGNITUDE OF U.

CCMMON/T120/IH,IPT,ITF,IU,IWT,HC,UC
CCMMON/CH/TFT3,DT3FCE,JIR3,R2J1,WTR3,WTT3,T2J1,DT2DR
C,DT3DTF

CCMMON/OC/DRDU,DRDUDE,URH
CCMMON/CD/DT3DU,DT3UDR,DT3UDE,UT3
CCMMON/CA/T3,DT3DR,DT3DE,DT3RDE
CCMMON/I/ANGLEW,DMR30G,DMBOG,SINEGB,COSEGB,TANEG,
CTANW,TOVERW

CCMMON/T22/E3,SINE3,CCSE3,BY3,SINBY3,COSBY3
CCMMON/QB/COSE4,DEGDE,DEGDR,EGB1,E4,SINE4,DEGRDE
CCMMON/CGU/ORDMEY,ORDMRY,DT3DMY,CT3MEY,MR3CR3,MR3OT3,MOLS,MORLS


```

C      COMPUTE U COMPONENT OF GUN MOTION
C      DMUOG=DMR30G*COSE4
C      UMC=3*DMUCG+UO
C      COMPUTE DOWNRANGE COMPONENT OF IV WITH GUN MOTION
C      R3UMC=UMG*COSEGB
C      RHUMO=R2J1/R3UMO
C      COMPUTE MOLS THE DEFLECTION EFFECT OF GUN MOTION CN GUN ORDERS
C      MCLS=3*RH1UMD
C      COMPUTE GUN MOTION EFFECTS CN CROSSRANGE MCLS
C      MORLS=MCLS*DMBOG
C      COMPUTE PARTIAL ELEVATION COMPONENT OF GUN MOTION WITH RANGE
C      (DEDR) AND ITS RECIPROCAL DRDSEV
C      DEDR=DEGDR*2*3.1416*UMO
C      DRDSEV=1/DEDR
C      DRDSEV=DRDSEV*SINEGB
C      DRDMRH=DRDU*COSEGB-DRDESE
C      COMPUTE DERIVATIVE OF RANGE WITH RESPECT TO ELEVATION GUN VELCCITYOPS00500
C      DRDMRY=3*DRDMRH
C      CRCECE=DRDSEV*COSEGB
C      DRDME3=DRDU*SINEGB+DRDECE
C      CRDMEY=3*CRDME3
C      COMPUTE THE DERIVATIVE OF RANGE WITH RESPECT CT ELEVATION GUN VELCCITY DRDMEY
C      GUN VELOCITY DRDE3G
C      CRCE3G=CRDMEY*COSE3+DRDMRY*SINE3
C      COMPUTE THE DERIVATIVE OF SLANT RANGE WITH RESPECT TO DOWN
C      HORIZONAL GUN VELOCITY DRD3OG
C      DRD3OG=DRDMRY*COSE3-DRDMEY*SINE3
C      COMPUTE DOWN RANGE EFFECT DUE TO PROJECTILE WEIGHT MR3OR3
C      MR3OR3=DRD3OG*DMR3OG
C      DT3DUC=DRDSEV*DT3DR
C      DT3DMR=DT3DUC*COSEGB-DT3DUC
C      COMPUTE EFFECT ON TIME OF FLIGHT DUE TO ELEVATION GUN
C      VELOCITY DT3MEY
C      DT3DMY=3*DT3DMR
C      DT3DUS=DRDECE*DT3DR
C      DT3DME=DT3DUC*SINEGB+DT3DUS
C      COMPUTE EFFECT ON TIME OF FLIGHT DUE TO ELEVATION GUN VELOCITY DT3MEY
C      DT3MEY=3*DT3DME
C      COMPUTE EFFECT ON TIME OF FLIGHT DUE TO HCRIZCENTAL GUN
C      VELCCITY DTH3OG
C      DTH3OG=DT3DMY*COSE3-DT3MEY*SINE3
C      COMPUTE EFFECT ON TIME OF FLIGHT DUE TO DCWRANGE GUN VELOCITY
C      MR3OT3=DTH3OG*DMR3OG
C      RETURN
C      END

```



```

SUBROUTINE WIND
C
C THIS SUBROUTINE CALCULATES WR3, THE TOTAL EFFECTS OF WIND ON
C ADVANCE RANGE R3 AND WT3 THE EFFECT ON TIME OF FLIGHT T3, AND
C THE WIND EFFECT ON CROSSRANGE
C
C COMMON/OGU/DRDMY,DRDMY,DT3DMY,DT3MEY,MR3OR3,MR3OT3,MOLS,MORLS
C COMMON/T22/E3,SINE3,COSE3,BY3,SINBY3,COSBY3
C COMMON/CH/T13,DT3FDE,J1R3,R2J1,W1R3,WT13,T2J1,DT2DR
C,DT3DTF
C COMMON/I/ANGLEW,DMR3OG,DMBOG,SINEGB,COSEGB,TANEG,
C TANW,TOVERW
C COMMON/T13/WX,WY,WXR,WYR
C COMMON/CW/DRDWRH,DTDWRH,WBG,WRHG,WRLS,WR3,WT3
C COMMON/CDOWNRANGE,COMPONENT OF WIND
C W1RG=WXR*SINBY3+WYR*COSE3
C COMPUTE CROSSRANGE COMPONENT OF WIND
C WBG=WXR*COSE3-WYR*SINBY3
C COMPUTE CROSSRANGE EFFECT
C WRLS=(T2J1-MOLS)*WBG
C COMPUTE PARTIAL OF SLANT RANGE WITH RESPECT TO ELEVATION RANGE
C W1ND DRDWE3
C DRDWE3=TCVERW-DRDMY*3
C COMPUTE PARTIAL OF SLANT RANGE WITH RESPECT TO SLANT RANGE WIND DRWR3
C DRDWR3=T2J1-DRDMY
C COMPUTE DERIVATIVE OF SLANT RANGE WITH RESPECT TO HCRIZNTALCCWN
C RANGE W1ND DRDWRH
C DRDWRH=DRDWE3*SINE3
C DRDWRH=DRDWR3*COSE3-DRDWOH
C COMPUTE WIND EFFECT ON R3 WR3
C WR3=DRDWRH*WRHG
C COMPUTE PARTIAL OF SLANT RANGE WITH RESPECT TO VERTICAL RANGE WIND
C DRDWRV
C DRDWRV=DRDWE3*COSE3+DRDWR3*SINE3
C COMPUTE DERIVATIVE OF TIME OF FLIGHT WITH RESPECT TO SLANT RANGE
C W1ND DTDWR3
C DTDWR3=-DT3DMY
C COMPUTE DERIVATIVE OF TIME OF FLIGHT WITH RESPECT TO HORIZONTAL
C RANGE W1ND DTDWRH
C DTDWRH=TOVERW*DT2DR-DT3MEY
C COMPUTE WIND EFFECT ON TIME OF FLIGHT WT3
C WT3=DTDWRH*WRHG
C
CPS000610
CPS000620
CPS000630
CPS000640

```



```
DT3DHWV=DT3DWE*COSE3+DTDWR3*SINE3
RETURN
END
```

```

SUBROUTINE TMONIT
  CCR MONITOR METER THIS SUBROUTINE DOES INITIAL SETUP AND
  FOR A SINGLE PARAMETER TABLE CORRECTING TO TARGET ELEVATION.
  LOCATES THE PROPER TABLE CORRECTING TO TARGET ELEVATION.
  THEN CALLS OTHER SUBROUTINES TO OBTAIN VALUES OF PARAMETER FROM
  TABLE, CHECKS FOR RANGE VIOLATION AND HIGH CR LOW ELEVATION ONCE
  FOR EACH PASS THRU BALLISTICS SECTION.
  TMC000C10
  OPS000730
  OPS000740
  OPS000750
  OPS000760
  OPS000770

```

```

  COMMON/T21/RTEMP,R3,RX3,RY3,RHOLD
  COMMON/T22/E3,SINE3,COSE3,BY3,SINBY3,COSBY3
  COMMON/A2/TABLE(11,17,32),K,T17,LIMVIO
  COMMON/N1/ICODEP,OPCEP,OPDED,TEMP2,TMP3,TMP10
  COMMON/A1/KORIND,STACK(11),HOLDB3(3),PRFET,IR3,EXACTE,B6,
  CPDE,ISRCH
  COMMON/T01/RCOEFF(8),KMTAB(11,2),ETABL(17,11),PUSHTB(11,2)
  INTEGER*4 T17,PUSHTB
  INTEGER*4 ETABL

```

```

  C
  IF(ICODEP-2)1,2,2
  CHECK IF RANGE GREATER THAN 50 YARDS
  C
  IF(RTEMP-50)3,3,4
  LIMVIO=-1
  C
  MINIMUM RANGE LIMIT VIOLATED
  CHECK FOR E3 GREATER THAN OR LESS THAN 35 DEGREES
  MIDIND=0
  IF(35-E3)5,5,6
  IF(MIDIND=4)
  IF(E3-80)6,8,8
  E3D=80
  GO TO 9
  E3C=E3

```

```

  STACK(2)=E3D
  LR3=RCOEFF(MIDIND+1)+E3C*RCOEFF(MIDIND+2)+E3D**2*RCOEFF(MIDIND+3)
  C
  +E3D**3*RCOEFF(MIDIND+4)
  IF(LR3-RTEMP)10,10,2
  IF(R3-LR3
  LIMVIO=1
  MINIMUM RANGE LIMIT VIOLATED
  C
  INITIAL IZSATION FOR EACH LOOKUP
  RHCLD=RTEMP
  EXACTE=0
  IF (ICODEP-3)30,31,31
  IF STACK(1)=1
  PARABOLIC INTERPOLATION
  TMC000120
  TMC000140
  TMC000150
  TMC000160
  TMC000170
  TMC000180
  TMC000190
  TMC000200
  TMC000210
  TMC000220
  TMC000230
  TMC000240
  TMC000250

```

```

  C
  2
  30
  C
  TMC000260
  TMC000270
  GAR000250
  GAR000260

```



```

C C C C C
SLBROUTINE AASRCH
THIS SUBROUTINE CONTROLS THE SELECTION OF CCEFFICIENTS FOR BRACKET
ING ELEVATION STACKS, THE CUBIC POLYNOMIAL EVALUATION, AND THE
INTERPOLATION BETWEEN ELEVATION STACKS FOR AA BALLISTICS. THIS
SUBROUTINE ALSO DETERMINES THE APPROPRIATE DERIVATIVES NEEDED FOR
AA BALLISTICS.
COMMON/A1/KORIND, STACK(11), HOLDB3(3), PRDET, IR3, EXACTE, B6,
CDPDE, ISRCH
COMMON/A2/TABLE(11,17,32), K, T17, LIMVIO
INTEGER*4 T17
B6= THE NUMBER OF TABLE LOOKUPS
B6=ISRCH
CHECK FOR STANDARD TABLES OF 4 CCEFFICIENTS
IF(KORIND-4)2,1,2
NCA-STANDARD TABLES LOOKUP
CALL SEARCH
IX=B6+1
ADDRESS OF FIRST COEFFICIENT IS STORED IN HOLDB3 MATRIX, HIGHEST
STACK IN HOLDB3(1)
HOLDB3(IX)=T17
IF (B6)20,20,21
B6=B6-1
GC TO 2
RETURN
STANDARD TABLE LOOKUP
FIND ADDRESS OF FIRST COEFFICIENT AND EVALUATE POLYNOMIAL, EVAL-
UATED PARAMETERS ARE STORED IN STACK MATRIX, HIGHEST ELEVATION IN
STACK(6) HIGHEST RANGE DERIVATIVE IN STACK (9)
CALL SEARCH
CALL POLYN
STACK(6+B6)=TEMP2
STACK(9+B6)=TMP10
IF (B6)4,4,5
B6=B6-1
GC TO 1
CALL INTERP
GET INTERPOLATED VALUE OF PARAMETERS AND STORE IN TEMP2
TEMP2=PRDET
GET ELEVATION DERIVATIVE AND STORE IN DPDEP
DPCEP=DPDE
NCRMAL LINEAR INTERPOLATION
B6=0
CHECK IF WE WANT A DERIVATIVE WITH RESPECT TO RANGE
IF (TMP3)6,6,7

```

AAS00010
OPS00800
OPS00810
OPS00820
OPS00830
OPS00840
OPS00850

GAR00340
OPS00790
AAS00050

AAS00070
OPS00860
OPS00870

OPS00880
OPS00890
OPS00900
AAS00130
AAS00140
AAS00150
AAS00160
AAS00170
AAS00180
AAS00190

AAS00210
AAS00220
AAS00230


```

C 6 NO RANGE DERIVATIVE
TMP10=TMP3
RETURN
C WANT RANGE DERIVATIVE
C CHECK FOR LINEAR OR PARABOLIC INTERPOLATION
C IF (STACK(1))8,8,9
C IF MIDDLE ELEVATION STACK IS GREATER THAN ADVANCE ELEVATION SET
C B6=1 FOR SPECIAL AA DERIVATIVE INTERPOLATION
9 IF (STACK(4)-STACK(2))8,8,10
10 B6=1
8 STACK(6+B6)=STACK(9+B6)
STACK(7+B6)=STACK(10+B6)
STACK(1)=0
EXACTE=0
CALL INTERP
TMP10=PR1ET
C MIXED PARTIAL OF ELEVATION AND RANGE STORED IN DPDED
C DPDED=DPDE
RETURN
END

```

AAS00240
AAS00250

AAS00260
OPS00910
OPS00920
AAS00270
AAS00280
AAS00290
AAS00300
AAS00310
AAS00320
AAS00330
AAS00340
OPS00930
AAS00350
AAS00360
AAS00370

```

C SUBROUTINE SEARCH
C THIS SUBROUTINE FINDS THE DIFFERENCE IN RANGE (IR3) TO BE USED IN
C DETERMINING EACH PARAMETER AND LOCATION OF FIRST COEFFICIENT
C TC BE USED (T17)
C COMMON/T21/RTMP,R3,RX3,RY3,RHOLD
C COMMON/N1/ICODEP,DPDED,TEMP2,TMP3,TMP10
C COMMON/A1/KORIND,STACK(11),HOLDB3(3),PR1ET,IR3,EXACTE,B6,
C DPDE,ISRCH
C COMMON/A2/TABLE(11,17,32),K,T17,LIMVID
REAL*4 IR3
INTEGER*4 T17

```

SEA00010
OPS00950
OPS00960
OPS00970

```

C WANT TO START AT THE LOWEST STACK FIRST SC NUMBER OF LOOKUPS IS
C SUBTRACTED FROM K THE HIGHEST STACK NUMBER
C K1=K-B6
C FIND THE NUMBER OF RANGE PARTITIONS
C N=TABLE(ICODEP,K1,2)
C FIND THE LOCATION OF HIGHEST RANGE PARTITION
C N=N+2
C FIND THE FIRST RANGE PARTITION LESS THAN R3
C AR3=RHOLD-TABLE(ICODEP,K1,N)
5 IF (AR3)1,1,2
2 T16=N-3
C T16=THE
C MINUS 1
C IR3=AR3

```

GAR00340
CPS00940
OPS00980
OPS00990
GAR00010

SEA00040
GAR00090
SEA00060
SEAC0070
OPS01000
OPS01010
SEA00090


```

C      1  GC TO 6
      4  N=2 CORRESPONDS TO ZERO RANGE
      3  IF(N-2)3,3,4
      3  A=N-1
      3  GC TO 5
      3  IR3=RHOLD
      3  AK=0
      3  AK= THE NUMBER OF CCEFFICIENTS TO BYPASS
      6  GO TO 7
      6  AK=KORIND*TI6
      7  FIND THE LOCATION OF FIRST COEFFICIENT
      7  TI7=AK+3+TABLE(ICODEP,K1,2)
      7  WRITE(6,102)TI7
      7  FCRMAT(10X, TI7=, I4)
      7  WRITE(6,100)K1
      7  FCRMAT(10X, K1=, I3)
      7  WRITE(6,101)IR3
      7  FCRMAT(10X, IR3=, E15.8)
      7  RETURN
      7  END

```

```

SEA000090
OPSO1020
SEA00100
SEA00110
SEA00120
SEA00130
SEA00140
OPSO1030
SEA00150
SEA00160
GAR00100
GAR000060
GAR000020
GAR000030
GAR000040
GAR000050
SEA00180
SEA00190

```

```

C      1  SUBROUTINE POLYN
C      2  THIS SUBROUTINE EVALUATES THE POLYNOMIAL FROM THE COEFFICIENTS AND
C      3  FINDS THE DERIVATIVE WITH RESPECT TO RANGE. THE PARAMETER IS FOUND
C      4  BY P=IR3**3+C3+IR3**2*IR3*C1+C0
C      5  COMMON/AL/ICODEP,DPDEP,TEMP2,TEMP3,IMP10
C      6  COMMON/AL/KORIND,STACK(11),HOLDB3(3),PRIET,IR3,EXACTE,B6,
C      7  CDPDE,ISRCH
C      8  COMMON/A2/TABLE(11,17,32),K,TI7,LIMVIO
C      9  REAL*4 IR3
C     10  INTEGER*4 TI7

```

```

POL000010
ANDOPS01050

```

```

C      1  WANT TO START AT THE LOWEST EVALUATION STACK FIRST SO THE NUMBER OF
C      2  LOOKUPS IS SUBTRACTED FROM K
C      3  K1=K-B6
C      4  TEMP2 HOLDS THE EVALUATED POLYNOMIAL
C      5  TEMP2=IR3**3*TABLE(ICODEP,K1,TI7+3)+IR3**2*TABLE(ICODEP,K1,TI7+2)+
C      6  IR3*TABLE(ICODEP,K1,TI7+1)+TABLE(ICODEP,K1,TI7)
C      7  IMP10=0
C      8  CHECK IF WE WANT A DERIVATIVE WITH RESPECT TO RANGE TMP3=0
C      9  NC, TMP3=1 YES
C     10  IF(TMP3-1)1,2,2
C     11  WRITE(6,102)TEMP2
C     12  FCRMAT(10X, TEMP2=, E15.8)
C     13  RETURN
C     14  COMPUTE DERIVATIVE BY FORMULA TMP10= 3**IR3**2*C3+2*IR3*C2+C1
C     15  TMP10=3*IR3**2*TABLE(ICODEP,K1,TI7+3)+2*IR3*TABLE(ICODEP,K1,TI7+2)

```

```

GAR000340
OPSO1040
GAR000110
GAR000120
POL000050
OPSO1060
OPSO1070
POL000060

```


GAR00140
GAR00150
GAR00160
GAR00170
GAR00180
POL00100
POL00110

SLI00010
OPS01080
CPS01090

GAR00340
CPS01100

SLI00050
SLI00060
SLI00070

FIN00010

GAR00340
FIN00030
FIN00040
FIN00050
GAR00230
GAR00240
FIN00060
FIN00070

DEC00010
CPS01110
OPS01120

OPS01130
DEC00030

```
C+TABLE(ICODEP,K1,T17+1)
  WRITE(6,100)TEMP2
  FCRMAT(10X,'TEMP2=',E15.8)
  WRITE(6,101)TMP10
  FCRMAT(10X,'TMP=',E15.8)
  RETURN
END
```

100
101

```
      SUBROUTINE SLIDE
      THIS SUBROUTINE SLIDES THE LOCATION OF PARAMETER VALUES AND
      DERIVATIVES VALUES UP BY 1 AT A TIME IN STACK
      COMMON/AL/KORIND,STACK(11),HOLDB3(3),PRTEL,IR3,EXACTE,B6,
      CDPDE,ISRCH
      INTEGER*4 T17
```

```
      DO 1 I=3,10
      STACK(14-I)=STACK(13-I)
      CONTINUE
      RETURN
      END
```

1

```
      SUBROUTINE FINDAL
      THIS SUBROUTINE FINDS THE NEXT HIGHER ELEVATION STACK BY
      INCREMENTING K
      COMMON/A2/TABLE(11,17,32),K,T17,LIMVIO
      INTEGER*4 T17
```

```
      CALL SLIDE
      K=K+1
      CALL DECSI
      WRITE(6,100)K
      FCRMAT(10X,'K=',I3)
      RETURN
      END
```

100

```
      SUBROUTINE DECSI
      THIS SUBROUTINE DECODES THE ELEVATION INFORMATION FROM EACH STACK
      AND STORES IT IN STACK(3)
      COMMON/A2/TABLE(11,17,32),K,T17,LIMVIO
      COMMON/AL/KORIND,STACK(11),HOLDB3(3),PRTEL,IR3,EXACTE,B6,
      CDPDE,ISRCH
      COMMON/N1/ICODEP,DPDEP,DPDED,TEMP2,TMP3,TMP10
```

```
      STACK(3)=TABLE(ICODEP,K,1)
      WRITE(6,100)STACK(3)
      FCRMAT(10X,'STACK(3)=' ,E15.8)
```

100

DEC00040
DEC00050

RETURN
END

INT0C010
OPS01140
ECPS01150
OPS01160
OPS01170
OPS01180
OPS01190
OPS01200
OPS01210
OPS01220

SLBROUTINE INTERP PERFORMS LINEAR OR PARABOLIC INTERPOLATIONS ON
THIS SUBROUTINE WHICH ARE FUNCTIONS OF ADVANCED RANGE AND ADVANCE
INPUT PARAMETERS THESE ARE POLYNOMIAL EVALUATED AT THE ADVANCED
ELEVATION. CERTAIN TERMS ARE POLYNOMIAL EVALUATED AT THE ADVANCED
RANGE AND CERTAIN ELEVATIONS THE PARAMETER INTERPOLATIONS ARE
PERFORMED TO OBTAIN THE VALUE AT THE ACTUAL ADVANCED ELEVATION.
THE INPUTS TO INTERP ARE PROVIDED FOR 2 OR 3 CHOSEN ELEVATION
VALUES OR STACKS BRACKETING THE ADVANCED ELEVATION AND ARE INSE-
RTED THROUGH THE STACK MATRIX ORIENTED FROM HIGHEST TO LOWEST
ELEVATION
CCVMCN/AL/KORIND,STACK(11),HOLDB3(3),PRTEI,IR3,EXACTE,B6,
CDPDE,ISRCH

GAR00340

INTEGER*4 T17
CHECK FOR LINEAR OR PARABOLIC INTERPOLATION
IF (STACK(1)-1)1,2,2
LINEAR INTERPOLATION B6=0 NORMAL LINEAR, B6=1 SPECIAL FOR SOME
AA DERIVATIVES

INT00030
OPS01230
OPS01240

INT00040

P2-P1
P1=STACK(6+B6)-STACK(7+B6)
E2-E1
DE1=STACK(3+B6)-STACK(4+B6)
CCOMPUTE DERIVATIVE WITH RESPECT CT ELEVATION DPDE
DPDE=P1/DE1

INT00050
INT00060

E3C-D1
DE2=STACK(2)-STACK(4+B6)
CCOMPUTE INTERPOLATED VALUE PRTEI
PRTEI=DPDE*DE2+STACK(7+B6)
RETURN

INT00070
INT00080
INT00090

PARABOLIC INTERPOLATION
P2-P1
DP1=STACK(7)-STACK(8)
E2-E1
DE3=STACK(4)-STACK(5)
CCOMPUTE ELEVATION DERIVATIVE AT LOWEST ELEVATION INTERVAL DPCEIH
DPCEIH=DP1/DE3

INT00100
INT00110

P3-P2
DP2=STACK(6)-STACK(7)
E3-E2
DE4=STACK(3)-STACK(4)
CCOMPUTE ELEVATION DERIVATIVE AT HIGH ELEVATION INTERVAL DPDE3H
DPDE3H=DP2/DE4

INT00120
INT00130

CCCOMPUTE FINITE DIFFERENCE SECOND DERIVATIVE CVER BOTH
INTERVALS DOPDE
CCPDH=DPD3H-DPDEIH

INT00140
OPS01250
INT00150
OPS01260
OPS01270
INT00160


```

C      E2-E1      STACK(3)-STACK(5)      INT00170
C      DDE7=DDPDH/DE7      INT00180
C      CCMPUTE FINITE DIFFERENCE DERIVATIVE AT LOWEST STACK DPDEK
C      E2D-E1      STACK(4)-STACK(5)      INT00190
C      DDE1=DE5*DDPDE      INT00200
C      DPDEK=DPDE1H-DDE1      INT00220
C      DE6=STACK(2)-STACK(5)      INT00240
C      TMP17=DDPDE*DE6*2      INT00250
C      CCMPUTE ELEVATION DERIVATIVE DPDE      INT00260
C      DPDE=TMP17+DPDEK      INT00280
C      IF THERE IS AN EXACTE ELEVATION STACK USE ITS PARAMETER VALUE      INT00290
C      B7=EXACTE      GAR00310
C      IF(B7)3,3,4      GAR00320
C      CCMPUTE INTERPOLATED VALUE PRTEI      INT00300
C      PRTEI=((0.5*TMP17+DPDEK)*DE6)+STACK(8)      INT00310
C      RETURN      INT00320
C      PRTEI=STACK(6+B7)      INT00330
C      WRITE(6,200)B6      INT00340
C      WFORMAT(10X,'B6=',I3)      INT00350
C      RETURN      INT00360
C      END      INT00370

```

88

```

SUBROUTINE ARTAN
THIS SUBROUTINE FINDS THE INVERSE TANGENT, GIVEN TWO PARAMETERS
AND DETERMINES THE CORRECT QUADRANT
COMMON/RT/COS1,SIN1,TAN
CHECK FOR ZERO DENOMINATOR
IF(ABS(COS1)-1.5E-5)10,10,11
PHI=ATAN(SIN1/COS1)
IF (SIN1.LT.0.0) GO TO 1
IF (COS1.LT.0.0) GO TO 2
GET HERE FOR FIRST QUADRANT ANGLE
TAN=PHI*57.293
GO TO 1000
GE HERE FOR SIN1 NEGATIVE
IF (COS1.LT.0.0) GO TO 3
GET HERE FOR SECOND QUADRANT ANGLE
PHI=ABS(PHI)+3.1415927/2
TAN=PHI*57.293

```


C	2	GC TO 1000	OPS01330
		GET HERE FOR FOURTH QUADRANT ANGLE	
		PHI=ABS(PHI)+3*3.1415927/2	
		TAN=PHI*57.293	
		GC TO 1000	
C	3	GC TO 1000	
		GET HERE FOR THIRD QUADRANT ANGLE	
		PHI=PHI+3.1415927	
		TAN=PHI*57.293	
		GC TO 1000	
C	10	GET HERE WHEN THE ABSOLUTE VALUE CD COS1 IS LESS THAN 0.000015	OPS01340
	12	TAN=90	
		IF(SIN1)12,12,13	
	13	TAN=270.0	
		GC TO 1000	
	1000	TAN=TAN	
		RETURN	
		END	

FIRST BALLISTIC TABLE

0.25000000E 01	0.50000000E 01	0.10000000E 02
0.50000000E 01	0.40000000E 01	0.40000000E 01
0.0	0.0	0.0
0.81000000E 04	0.76000000E 04	0.81000000E 04
0.12800000E 05	0.12900000E 05	0.13000000E 05
0.17900000E 05	0.16700000E 05	0.17100000E 05
0.20100000E 05	-0.34974755E-02	-0.41918755E-02
-0.38096944E-02	0.12058103E-02	0.12079733E-02
0.12069279E-02	0.32674269E-07	0.32762074E-07
0.31923889E-07	0.16752537E-11	0.16956610E-11
0.17281445E-11	0.11789101E 02	0.12832829E 02
0.12791668E 02	0.19907146E-02	0.20769057E-02
0.200690537E-02	0.78480014E-07	0.79382369E-07
0.82826546E-07	0.22032957E-11	0.27101221E-11
0.19844543E-11	0.24863998E 02	0.25228867E 02
0.24542694E 02	0.29904984E-02	0.30408958E-02
0.29724282E-02	0.61848766E-07	0.71283523E-07
0.51397571E-07	0.28494516E-11	0.39738976E-11
0.32850805E-11	0.37271606E 02	0.39167862E 02
0.41479630E 02	0.36103753E-02	0.38892061E-02
0.37697789E-02	0.69847715E-07	0.86932687E-07
0.10661853E-06	0.19360208E-10	0.38425110E-10
0.20725921E-10	0.0	0.0
0.50509995E 02	0.0	0.0
0.44667125E-02	0.0	0.0
-0.44618109E-09	0.0	0.0
0.33343110E-08	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0

FIRST BALLISTIC TABLE

0.17500000E 02	0.25000000E 02	0.32500000E 02
0.50000000E 01	0.50000000E 01	0.50000000E 01
0.0	0.0	0.0
0.81000000E 04	0.81000000E 04	0.81000000E 04
0.13200000E 05	0.13700000E 05	0.13600000E 05
0.16000000E 05	0.16700000E 05	0.16200000E 05
0.18300000E 05	0.18500000E 05	0.17300000E 05
-0.29560241E-02	-0.40703043E-02	-0.42205453E-02
0.12059226E-02	0.12073196E-02	0.12070243E-02
0.24487030E-07	0.25200095E-07	0.36412043E-07
0.16065482E-11	0.16057173E-11	0.15721824E-11
0.12882056E 02	0.12938739E 02	0.12998223E 02
0.20932737E-02	0.21059385E-02	-0.21295245E-02
0.75142850E-07	0.76349011E-07	0.73353135E-07
0.37794646E-11	0.43286815E-11	0.57454918E-11
0.26008972E 02	0.27875519E 02	0.27874924E 02
0.31318283E-02	0.33538149E-02	0.34593889E-02
0.97963493E-07	0.99532429E-07	0.11563230E-06
0.42486067E-11	0.18975294E-10	0.30372982E-10
0.35642242E 02	0.39358093E 02	0.38190216E 02
0.38178882E-02	0.45796409E-02	0.47449805E-02
0.12642954E-06	0.15239954E-06	0.32450924E-06
0.33356526E-10	0.16996594E-09	0.17871009E-09
0.45498886E 02	0.49089996E 02	0.44038147E 02
0.49869716E-02	0.73166266E-02	0.62974123E-02
0.23200217E-06	-0.39996248E-05	0.31993761E-06
0.19026496E-09	0.18332479E-07	0.12781609E-08
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0

FIRST BALLISTIC TABLE

0.40000000E 02	0.45000000E 02	0.50000000E 02
0.50000000E 01	0.60000000E 01	0.60000000E 01
0.0	0.0	0.0
0.81000000E 04	0.77000000E 04	0.65000000E 04
0.14300000E 05	0.12100000E 05	0.11400000E 05
0.16400000E 05	0.15000000E 05	0.13900000E 05
0.17200000E 05	0.16400000E 05	0.15800000E 05
-0.49694702E-02	0.17000000E 05	0.16700000E 05
0.12079945E-02	-0.52835867E-02	-0.39421432E-02
0.36857620E-07	0.12077424E-02	0.12045556E-02
0.16209768E-11	0.37571279E-07	0.39595079E-07
0.13060121E 02	0.16040468E-11	0.14275551E-11
0.21471460E-02	0.12258004E 02	0.98921366E 01
0.75212199E-07	0.20886378E-02	0.19173657E-02
0.66804912E-11	0.73567833E-07	0.62417541E-07
0.20857330E 02	0.65378172E-11	0.55467107E-11
0.39206222E-02	0.23429688E 02	0.21439667E 02
0.15915901E-06	0.31640455E-02	0.29692831E-02
0.84564272E-10	0.11295219E-06	0.13460090E-06
0.40578979E 02	0.26688915E-10	0.16096638E-10
0.58729537E-02	0.34208740E 02	0.29956024E 02
0.51118286E-06	0.45818202E-02	0.39915740E-02
0.77441120E-09	0.29451155E-06	0.21310615E-06
0.45998566E 02	0.20320133E-09	0.10570102E-09
0.84047653E-02	0.41760468E 02	0.39037048E 02
0.85710417E-06	0.67654736E-02	0.62141754E-02
0.66667205E-08	0.91666840E-06	0.33975215E-06
0.0	0.16666648E-08	0.13616877E-08
0.0	0.46509995E 02	0.45900024E 02
0.0	0.98000355E-02	0.14461782E-01
0.0	0.39996394E-05	-0.54452228E-04
0.0	0.10000807E-07	0.20822944E-06

FIRST BALLISTIC TABLE

C.55000000E 02	0.60000000E 02	0.65000000E 02
C.60000000E 01	0.60000000E 01	0.60000000E 01
0.0	0.0	0.0
C.72000000E C4	0.67000000E C4	0.70000000E 04
0.11500000E C5	0.10400000E C5	C.11600000E 05
0.14100000E 05	0.13400000E 05	C.14300000E 05
0.15700000E C5	0.15400000E C5	0.15400000E 05
0.16400000E 05	0.16200000E 05	C.16000000E 05
-0.55188313E-C2	-0.43662786E-C2	0.12069531E-C2
0.12082359E-C2	0.12050325E-C2	-0.49820393E-C2
0.38502005E-C7	0.40173283E-C7	0.39765769E-C7
0.16012643E-C11	0.14782073E-C11	0.15681120E-C11
0.11291344E-C2	0.10322681E-C2	0.10930743E-C2
0.20298087E-C2	0.19529735E-C2	0.20218999E-C2
0.70850206E-C7	0.72393732E-C7	0.65509482E-C7
0.66418190E-C11	0.51411896E-C11	0.78941255E-C11
0.21857910E-C2	0.18802277E-C2	0.22388031E-C2
0.30537299E-C2	0.27169837E-C2	0.31759206E-C2
0.13038471E-C6	0.13824149E-C6	0.12208204E-C6
0.23905405E-C10	0.12156998E-C10	0.41806447E-C10
0.31095810E-C2	0.28526825E-C2	0.32688782E-C2
0.43398701E-C2	0.39764419E-C2	0.48650429E-C2
0.19040306E-C6	0.16822884E-C6	0.41042381E-C6
0.19736818E-C9	0.13408284E-C9	0.33022429E-C9
0.39339233E-C2	0.38227463E-C2	0.38980469E-C2
0.66321280E-C2	0.65979213E-C2	0.71484111E-C2
0.72187152E-C6	0.28173861E-C6	C.10000003E-C5
0.18181721E-C8	0.20875475E-C8	0.27777725E-C8
0.44959991E-C2	0.44759995E-C2	0.44229996E-C2
0.10916717E-C1	0.11799712E-C1	0.12432531E-C1
-C.48341775E-C9	-0.19972540E-C9	-0.59923159E-C5
0.28334391E-C7	0.49993904E-C7	0.66649591E-C7

FIRST BALLISTIC TABLE

0.70000000E 02	0.75000000E 02	0.80000000E 02
0.60000000E 01	0.60000000E 01	0.60000000E 01
0.0	0.0	0.0
0.64000000E 04	0.69000000E 04	0.72000000E 04
0.11100000E 05	0.10800000E 05	0.10800000E 05
0.13600000E 05	0.13000000E 05	0.13100000E 05
0.15000000E 05	0.14800000E 05	0.14900000E 05
0.15800000E 05	0.15700000E 05	0.15600000E 05
-0.20820610E-02	-0.33271667E-02	-0.33796197E-02
0.12042467E-02	0.12068197E-02	0.12071456E-02
0.40758277E-07	0.39827619E-07	0.39681169E-07
0.15065128E-11	0.16479977E-11	0.16992640E-11
0.97699099E 01	0.10764632E 02	0.11381729E 02
0.19324361E-02	0.20064218E-02	0.20611000E-02
0.62336255E-07	0.73499336E-07	0.77397431E-07
0.68052898E-11	0.67833898E-11	0.73805797E-11
0.20937790E 02	0.20111404E 02	0.20151810E 02
0.20146058E-02	0.29214357E-02	0.29439295E-02
0.14150254E-06	0.15559669E-06	0.14778215E-06
0.26913929E-10	0.18597290E-10	0.23287483E-10
0.29781647E 02	0.27490082E 02	0.27986465E 02
0.43069944E-02	0.39403625E-02	0.40876716E-02
0.30139967E-06	0.22125425E-06	0.19263251E-06
0.18706996E-09	0.13275185E-09	0.17903551E-09
0.36915344E 02	0.36075699E 02	0.37016357E 02
0.64515248E-02	0.63271398E-02	0.68099126E-02
0.52850027E-06	0.18880974E-06	0.63638583E-06
0.18350153E-08	0.18803430E-08	0.24494740E-08
0.43360001E 02	0.43309998E 02	0.42939987E 02
0.11699837E-01	0.12549311E-01	0.12483109E-01
-0.14984453E-05	-0.69934404E-05	-0.69978569E-05
0.44996519E-07	0.74985394E-07	0.71661873E-07

SECOND BALLISTIC TABLE

0.25000000E 01	0.50000000E 01	0.10000000E 02
0.50000000E 01	0.40000000E 01	0.50000000E 01
0.0	0.0	0.0
0.65000000E 04	0.66000000E 04	0.66000000E 04
0.12100000E 05	0.12100000E 05	0.11800000E 05
0.16600000E 05	0.16600000E 05	0.16400000E 05
0.20100000E 05	-0.40924110E-01	0.13500000E 05
-0.39640784E-01	0.26602026E-01	-0.36135754E-01
0.26675086E-01	0.93329294E-06	0.26290335E-01
0.52801412E-06	0.64113589E-10	0.94456210E-06
0.64565254E-10	0.23462082E-03	0.62169797E-10
0.23028836E-03	0.47728159E-01	0.23250787E-03
0.47238188E-01	0.21609903E-05	0.47283698E-01
0.21471496E-05	0.15220304E-05	0.21349842E-05
0.15137572E-09	0.58783569E-03	0.14881628E-09
0.58931641E-03	0.85619926E-01	0.55707983E-03
0.85926175E-01	0.48423403E-05	0.31760764E-01
0.48035499E-05	0.47771065E-10	0.48296279E-05
0.23412466E-10	0.10753957E-04	0.93552666E-10
0.10753142E-04	0.13378012E-00	0.10450164E-04
0.13171929E-00	0.44058988E-05	0.13311303E-00
0.45075294E-05	0.75881812E-09	0.61718356E-05
0.54206484E-09	0.0	0.68265704E-09
0.16145600E-04	0.0	0.13580984E-04
0.17314088E-00	0.0	0.16377027E-00
0.18058655E-03	0.0	0.99265362E-05
-0.56015138E-06	0.0	0.26510321E-08
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0

SECOND BALLISTIC TABLE

0.15000000E C2	0.20000000E 02	0.25000000E 02
0.50000000E 01	0.50000000E 01	0.50000000E 01
0.0	0.0	0.0
0.66000000E C4	0.67000000E 04	0.67000000E 04
0.11700000E C5	0.11600000E C5	0.11500000E 05
0.16100000E C5	0.15800000E C5	0.15500000E C5
0.18300000E C5	0.18000000E C5	0.17700000E C5
-0.31554557E-C1	-0.31491395E-C1	-0.22941940E-01
0.25779448E-01	0.25082666E-01	0.24186213E-01
0.94695156E-C6	0.93580064E-C6	0.91914688E-06
0.60011260E-10	0.58165986E-10	0.55651732E-10
0.22862090E 03	0.22753232E 03	0.22002965E 03
0.46527773E-C1	0.45864277E-C1	0.44413030E-01
0.20808957E-C5	0.20489497E-C5	0.19700592E-05
0.14860645E-09	0.15022479E-09	0.15091257E-09
0.53980225E C3	0.51918066E C3	0.49532886E 03
0.79564214E-01	0.77037036E-C1	0.74122190E-01
0.47447866E-C5	0.45918487E-C5	0.43956334E-05
0.15901787E-C9	0.22402442E-C9	0.28825475E-09
0.99521567E 03	0.94033594E C3	0.88057104E 03
0.13141870E 00	0.12864327E 00	0.12473357E 00
0.65259246E-05	0.66923176E-C5	0.65690820E-05
0.10109917E-C8	0.14400028E-C8	0.19796815E-08
0.13268040E C4	0.12711013E C4	0.12079033E 04
0.17620784E 00	0.18138206E 00	0.18635255E 00
0.12080532E-C4	0.13822636E-C4	0.14614283E-C4
0.51119144E-08	0.92249621E-C8	0.16653708E-07
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0

SECOND BALLISTIC TABLE

0.30000000E 02	0.35000000E 02	0.40000000E 02
0.60000000E 01	0.60000000E 01	0.60000000E 01
0.0	0.0	0.0
0.68000000E 04	0.68000000E 04	0.69000000E 04
0.11500000E 05	0.11300000E 05	0.11300000E 05
0.15100000E 05	0.14800000E 05	0.14500000E 05
0.16900000E 05	0.16800000E 05	0.16400000E 05
0.17900000E 05	0.17800000E 05	0.17300000E 05
-0.28644178E-01	-0.21841597E-01	-0.28780818E-01
0.23122858E-01	0.21869406E-01	0.20466059E-01
0.88734464E-06	0.85127652E-06	0.80088455E-06
0.53501117E-10	0.50601703E-10	0.47954404E-10
0.21506778E 03	0.20397606E 03	0.19508344E 03
0.43050058E-01	0.40880807E-01	0.38795494E-01
0.19000763E-05	0.18118699E-05	0.17169922E-05
0.15483695E-09	0.15197599E-09	0.15403537E-09
0.47548755E 03	0.43850122E 03	0.41217017E 03
0.71608245E-01	0.66894293E-01	0.63341439E-01
0.42915708E-05	0.39733904E-05	0.38428825E-05
0.34277914E-09	0.38661874E-09	0.42076853E-09
0.80490918E 03	0.73785181E 03	0.66797239E 03
0.11687243E 00	0.11056018E 00	0.10242707E 00
0.74256477E-05	0.64986916E-05	0.63576917E-05
0.18582860E-08	0.25061468E-08	0.26545504E-08
0.10502024E 04	0.10050500E 04	0.90379736E 03
0.16334862E 00	0.17126489E 00	0.15902948E 00
0.15848927E-04	0.14069570E-04	0.16356615E-04
0.99359916E-08	0.23502199E-07	0.22665120E-07
0.12393630E 04	0.12140000E 04	0.10767466E 04
0.22717845E 00	0.26776493E 00	0.25129491E 00
0.42509957E-04	0.21551561E-03	0.48779285E-04
0.53700973E-07	-0.21170064E-06	0.24917728E-06

SECOND BALLISTIC TABLE

0.450000000E 02	0.500000000E 02	0.550000000E 02
0.600000000E 01	0.600000000E 01	0.600000000E 01
0.0	0.0	0.0
0.690000000E 04	0.700000000E 04	0.710000000E 04
0.113000000E 05	0.113000000E 05	0.114000000E 05
0.143000000E 05	0.141000000E 05	0.141000000E 05
0.160000000E 05	0.159000000E 05	0.156000000E 05
0.169000000E 05	0.167000000E 05	0.164000000E 05
-0.20488478E-01	-0.22628419E-01	-0.29156726E-01
0.18889520E-01	0.17182510E-01	0.15346885E-01
0.74784754E-06	0.68188183E-06	0.60863249E-06
0.44432485E-10	0.41117207E-10	0.37417167E-10
0.18032591E 03	0.16778123E 03	0.15302098E 03
0.35984889E-01	0.33202246E-01	0.30080359E-01
0.15812593E-05	0.14576026E-05	0.13108693E-05
0.15193713E-09	0.15019665E-09	0.14746657E-09
0.38244409E 03	0.34946387E 03	0.31834912E 03
0.59282638E-01	0.54629341E-01	0.50183192E-01
0.36411075E-05	0.34203986E-05	0.31512909E-05
0.45449089E-09	0.47187854E-09	0.51609961E-09
0.60533374E 03	0.53955396E 03	0.48698462E 03
0.94732240E-01	0.86631000E-01	0.79878032E-01
0.65658924E-05	0.53337844E-05	0.60712609E-05
0.27344842E-08	0.32452279E-08	0.34064707E-08
0.79880640E 03	0.73175977E 03	0.63196631E 03
0.14392483E 00	0.14196527E 00	0.12468064E 00
0.14867687E-04	0.14126343E-04	0.12899101E-04
0.21610344E-07	0.35084110E-07	0.31270943E-07
0.95618970E 03	0.87240991E 03	0.75603979E 03
0.23028231E 00	0.24170452E 00	0.21612413E 00
0.44658402E-04	0.51615963E-04	0.36492085E-04
0.24580714E-06	0.51307580E-06	0.50168404E-06

SECCND BALLISTIC TABLE

C.6CCCCC00E C2	0.65C00000E C2	0.70000000E 02
0.6CCCCC00E 01	0.6CCCCC00E C1	0.60000000E 01
0.0	0.0	0.0
C.72CCCCC0E C4	0.75C00000E C4	0.7700C0C0E 04
0.115C00C0E C5	0.117000C0E C5	C.120CCCC0E 05
0.14C000C0E C5	0.14100000E C5	0.144C00C0E 05
0.155CCCC0E C5	0.154C00C0E C5	0.153CCCC0E C5
0.162C0000E C5	0.16C000C0E C5	0.158CCCC0E 05
-0.241746C5E-C1	-0.32901440E-C1	-0.31744126E-01
0.13385557E-C1	0.11338542E-C1	0.91918670E-02
0.53091730E-C6	0.44158674E-06	0.35281141E-06
0.33232861E-10	0.29298231E-10	0.245C13C4E-10
0.13628899E-C3	0.12222952E-C3	0.10286295E-03
0.26627243E-01	0.23337778E-01	0.19412329E-01
0.11473576E-C5	0.10045978E-C5	0.60708725E-06
0.141746C9E-09	0.139C3680E-C9	0.13084864E-09
0.28329688E-C3	0.24829070E-C3	0.21167293E-03
C.4500C017E-C1	0.398042C5E-C1	0.34422C44E-01
0.28866361E-05	0.25258360E-C5	0.198566C7E-05
0.5296C347E-09	0.58544660E-C9	0.71619755E-09
0.42210547E-C3	0.36647168E-C3	0.315C7993E-03
0.708C1616E-01	0.63388050E-01	0.5745C3C2E-01
C.52C35830E-C5	0.52556379E-C5	0.69982716E-05
0.36956218E-08	0.42782418E-C8	0.5312728C0E-08
0.55252C26E-C3	0.46718872E-C3	0.37693311E-03
0.11524916E-C0	0.10171C26E-C0	0.84457278E-01
0.12569270E-C4	0.14559499E-C4	0.16544145E-04
0.35797975E-C7	0.41944464E-07	0.36203026E-07
0.653C4980E-C3	0.54254C04E-C3	0.42782983E-03
0.2C639485E-C0	0.18000495E-C0	0.13581479E-00
-C.4145C883E-04	-0.81888C22E-C4	-0.14482C73E-C4
0.89489060E-06	0.97808334E-C6	0.53329347E-06

SECOND BALLISTIC TABLE

0.75000000E 02	0.80000000E 02
0.50000000E 01	0.50000000E 01
0.0	0.0
0.81000000E 04	0.81000000E 04
0.12500000E 05	0.12800000E 05
0.14600000E 05	0.14700000E 05
0.15700000E 05	0.15600000E 05
-0.36948875E -01	-0.14113124E -01
0.69814064E -02	0.46739683E -02
0.25841609E -06	0.17448326E -06
0.19570623E -10	0.12152678E -10
0.83880356E -02	0.56320923E -02
0.15458006E -01	0.10449842E -01
0.61404018E -06	0.37701369E -06
0.12338225E -09	0.90918648E -10
0.17431053E -03	0.12323389E -03
0.28800629E -01	0.20682942E -01
0.16801541E -05	0.12522632E -05
0.85933771E -09	0.79211659E -09
0.25014171E -02	0.17248473E -03
-0.50448716E -01	0.35895605E -01
-0.20928656E -06	0.13514054E -05
0.12946110E -07	0.11027577E -07
0.32262988E -03	0.21397000E -03
0.11146045E -00	0.73082030E -01
-0.71440489E -04	-0.37487727E -04
0.68820083E -06	0.41663935E -06
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0

THIRD BALLISTIC TABLE

0.50000000E 01	0.12500000E 02	0.20000000E 02
0.20000000E 01	0.20000000E 01	0.20000000E 01
0.0	0.0	0.0
0.10000000E 05	0.12100000E 05	0.13200000E 05
-0.44590539E 00	-0.53771842E 00	-0.44000703E 00
0.80811024E-01	0.80891967E-01	0.80717921E-01
-0.24198471E-05	-0.24224100E-05	-0.23536995E-05
0.39302381E-10	0.51937607E-10	0.58261590E-10
0.64352954E 03	0.71536743E 03	0.78840942E 03
0.44786330E-01	0.48332345E-01	0.48795857E-01
-0.15720543E-05	-0.24149340E-05	-0.30826341E-05
0.65199984E-10	0.14911321E-09	0.29150904E-09

THIRD BALLISTIC TABLE

C.27500000E C2	0.35000000E 02	C.42500000E 02
0.20000000E 01	0.20000000E 01	0.20000000E 01
0.0	0.0	0.0
0.13100000E 05	0.12500000E 05	0.12500000E 05
-0.23965603E 00	-0.10349798E 00	0.58424587E-01
0.80394506E-01	0.80158770E-01	0.79893589E-01
-0.22453005E-05	-0.21576352E-05	-0.20636116E-05
0.60657895E-10	0.62984548E-10	0.63652652E-10
0.80331128E 03	0.78743481E 03	0.83022071E 03
0.51646619E-01	0.55954114E-01	0.55985902E-01
-0.32957878E-05	-0.32531534E-05	-0.25534246E-05
0.32480907E-09	0.26014990E-09	0.15170151E-09

THIRD BALLISTIC TABLE

0.50000000E 02	0.57500000E 02	0.65000000E 02
0.20000000E 01	0.20000000E 01	0.20000000E 01
0.0	0.0	0.0
0.12600000E 05	0.12300000E 05	0.12100000E 05
0.26067120E 00	0.31261128E 00	0.36220452E 00
0.79581824E -01	0.79466760E -01	0.79360187E -01
-0.19605204E -05	-0.19073050E -05	-0.18607052E -05
0.62568561E -10	0.63513209E -10	0.63888755E -10
0.81608350E -03	0.80682739E -03	0.80098901E -03
0.55133119E -01	0.56200292E -01	0.56569297E -01
-0.15843616E -05	-0.88705434E -06	-0.12379900E -06
-0.32985684E -10	-0.20511468E -09	-0.38566927E -09

THIRD BALLISTIC TABLE

0.72500000E 02	0.80000000E 02
0.20000000E 01	0.20000000E 01
0.0	0.0
0.11900000E 05	0.11800000E 05
0.28043833E 00	0.41003025E 00
0.79310536E-01	0.75264224E-01
-0.18331775E-05	-0.18121900E-05
0.64555070E-10	0.64770703E-10
0.79335693E 03	0.78961401E 03
0.56353331E-01	0.57576522E-01
0.90817429E-06	0.48777076E-06
-0.60241212E-09	-0.54249538E-09

FOURTH BALLISTIC TABLE

C.50000000E 01	0.30000000E C2	0.55000000E 02
0.20000000E 01	0.20000000E C1	0.20000000E 01
0.0	0.0	0.0
C.13000000E C5	0.13000000E C5	C.13000000E 05
-0.28341883E-02	-0.37907360E-C2	-0.60301088E-02
0.50878822E-04	0.52425778E-C4	0.55562079E-04
0.11742525E-C9	-0.18399496E-C9	-0.97077346E-09
0.65568590E-13	0.94545845E-13	0.16145548E-12
0.62518965E 00	0.85653239E C0	0.91206771E 00
0.97729615E-C4	0.13786182E-C3	0.16013747E-03
-0.83450669E-09	-0.10282797E-C7	-0.28855379E-07
0.32401886E-12	0.19301071E-11	0.91562374E-11

FOURTH BALLISTIC TABLE

```

C.8CCCCCCE C2
O.2CCCCCCE 01
O.0
C.12CCCCCCE C5
-0.74683204E-02
-0.57530691E-04
-0.14748769E-08
O.20581860E-12
C.9443751CE C0
-0.18925159E-03
-0.58251516E-07
O.22669838E-10

```


FIFTH BALLISTIC TABLE

C.500000000E 01	0.150000000E 02	0.250000000E 02
0.200000000E 01	0.300000000E 01	0.300000000E 01
0.0	0.0	0.0
0.121000000E 05	0.128000000E 05	0.131000000E 05
-0.22236040E 00	0.193000000E 05	0.185000000E 05
-0.53894799E-03	0.15188670E 00	-0.93585432E-01
-0.40779814E-05	-0.21471674E-03	0.19803554E-03
-0.26912653E-10	-0.39492988E-05	0.38012631E-05
0.52364282E 03	-0.33552883E-10	-0.28371888E-10
0.84621072E-01	0.57215796E 03	0.58920825E 03
0.46131991E-05	0.84626019E-01	0.82485080E-01
0.21487628E-09	-0.55600822E-05	-0.53406056E-05
0.0	0.41261439E-09	0.58536398E-09
0.0	0.10013298E 04	0.97171997E 03
0.0	0.67116618E-01	0.79683363E-01
0.0	0.55005166E-05	0.74994305E-05
0.0	0.33316916E-08	0.66678254E-08

FIFTH BALLISTIC TABLE

C.35CCCCCCE C2	0.45000000E 02	C.550CCCCCE 02
C.30000000E 01	0.30000000E 01	C.300CCCCCE 01
0.0	0.0	0.0
C.125CCCCCE C5	0.11300000E C5	C.108CCCCCE 05
C.17800000E 05	0.15100000E 05	0.14700000E 05
-0.41843438E C0	-0.48467010E 00	-0.49684834E C0
C.69065648E-C3	0.84353215E-C3	0.90644206E-03
0.36389201E-C5	0.35661506E-05	C.35226440E-05
-0.21692620E-10	-0.20071875E-10	-0.19723043E-10
0.56617749E C3	0.43536328E C3	C.39534106E 03
0.81950307E-01	0.78123868E-01	0.73956490E-01
-0.45800498E-C5	0.13425802E-C6	0.13913241E-C5
0.66831674E-C9	-0.12577402E-C9	-0.18058495E-C9
0.93731982E C3	0.72739648E 03	0.69429565E 03
0.89232802E-C1	0.79372883E-C1	0.83643973E-01
0.47504655E-C4	-0.43911068E-05	-0.64221495E-05
-0.88343370E-C7	0.32075611E-08	0.48752788E-08

FIFTH BALLISTIC TABLE

C.65CCCCCOE	C2	0.7750CCCCOE	C2
0.30CCCCOOE	01	0.30CCCCOOE	C1
0.0		0.0	
0.104CCCCOE	C5	0.124000COE	C5
0.145000COE	C5	0.144000COE	C5
-0.48594517E	C0	-0.49406999E	C0
C.92464546E	-03	0.95620775E	-C3
0.34981940E	-05	0.34736058E	-C5
-0.20057053E	-10	-0.19873145E	-10
0.36494556E	C3	0.34957910E	C3
0.70768952E	-C1	0.69327235E	-C1
0.19479094E	-C5	0.18963892E	-C5
-0.15469485E	-09	-0.72263792E	-10
0.67706396E	03	0.66901294E	C3
0.89440107E	-C1	0.90105951E	-C1
-0.12786430E	-C4	-0.10780218E	-C4
0.92809280E	-C8	0.11096141E	-C7

SIXTH BALLISTIC TABLE

0.50000000E 01	0.30000000E 02	0.55000000E 02
0.20000000E 01	0.20000000E 01	0.20000000E 01
0.0	0.0	0.0
0.12500000E 05	0.12500000E 05	0.12500000E 05
-0.40031224E-02	-0.34229141E-02	-0.56032427E-02
0.46734887E-05	0.38393910E-05	0.67141145E-05
-0.11574185E-09	0.12075130E-09	-0.62236061E-09
0.15426164E-12	0.14128960E-12	0.19520080E-12
0.32573949E 00	0.33625793E 00	0.36970794E 00
0.15521410E-03	0.14298031E-03	0.15486017E-03
-0.52424767E-08	-0.54800893E-08	-0.28209815E-07
0.42974982E-12	0.11090616E-11	0.78686432E-11

SIXTH BALLISTIC TABLE

```

0.80000000E 02
0.20000000E 01
0.0
-0.12500000E 05
-0.69053061E-02
-0.86051368E-05
-0.11421217E-08
0.23524195E-12
0.38881576E 00
-0.16382609E-03
-0.46486416E-07
0.16285445E-10

```


SEVENTH BALLISTIC TABLE

0.50000000E 01	0.12500000E 02	0.20000000E 02
0.20000000E 01	0.30000000E 01	0.30000000E 01
0.0	0.0	0.0
0.12000000E 05	0.12300000E 05	0.12500000E 05
-0.10400724E 00	0.15700000E 05	0.16000000E 05
-0.81964128E-04	-0.19927856E-01	0.47894921E-01
-0.24321980E-05	-0.74988275E-04	-0.21399414E-03
0.38499468E-10	-0.23680141E-05	-0.21303622E-05
-0.27935596E 03	0.34406769E-10	0.30822858E-10
-0.46270249E-01	-0.29212134E 03	-0.30100195E 03
0.12425826E-04	-0.41252948E-01	-0.42060789E-01
-0.31882696E-09	0.87435765E-05	0.10397433E-04
0.0	0.45569370E-09	0.20758506E-09
0.0	-0.31476685E 03	-0.31246606E 03
0.0	0.30210268E-01	0.34307875E-01
0.0	0.10515914E-04	0.90497397E-05
0.0	-0.86408836E-09	-0.12371300E-08

SEVENTH BALLISTIC TABLE

0.27500000E 02	0.35000000E 02	0.42500000E 02
0.30000000E 01	0.20000000E 01	0.20000000E 01
0.0	0.0	0.0
0.12500000E 05	0.12400000E 05	0.12300000E 05
0.16000000E 05	0.25243294E 00	0.29942024E 00
0.15360188E 00	-0.54136757E-03	-0.63120294E-03
-0.38518966E-03	-0.21907708E-05	-0.21524647E-05
-0.22474687E-05	0.23537020E-10	0.21259883E-10
-0.26968414E-10	-0.29566284E 03	-0.29190322E 03
-0.30073047E 03	-0.45320768E-01	-0.40129982E-01
-0.43030698E-01	0.13632462E-04	0.10684284E-04
0.11562372E-04	-0.66856698E-09	-0.34815195E-09
-0.84903848E-10	0.0	0.0
-0.31397021E 03	0.0	0.0
0.31575285E-01	0.0	0.0
0.66508674E-05	0.0	0.0
-0.96373221E-09	0.0	0.0

SEVENTH BALLISTIC TABLE

0.50000000E 02	0.57500000E 02	0.65000000E 02
0.30000000E 01	0.30000000E 01	0.30000000E 01
0.0	0.0	0.0
0.12100000E 05	0.11900000E 05	0.11800000E 05
0.16700000E 05	0.16300000E 05	0.16000000E 05
0.37056339E 00	0.43011218E 00	0.43593097E 00
-0.74601475E-03	-0.83902106E-03	-0.86247409E-03
-0.21101450E-05	-0.20754605E-05	-0.20603393E-05
0.18700735E-10	0.18589480E-10	0.15708629E-10
-0.28313037E-03	-0.27464209E-03	-0.27008325E-03
-0.39473955E-01	-0.38341399E-01	-0.36503717E-01
0.51799875E-05	0.73656047E-05	0.59303948E-05
-0.19817599E-09	0.24281105E-10	0.20906725E-09
-0.28869995E-03	-0.29744995E-03	-0.30194995E-03
0.41098051E-01	0.39064229E-01	0.38880158E-01
0.12018553E-04	0.40233144E-05	-0.18969629E-04
0.79958852E-07	0.14328140E-06	0.26159921E-06

SEVENTH BALLISTIC TABLE

0.72500000E 02	0.80000000E 02
0.30000000E 01	0.30000000E 01
0.0	0.0
0.11800000E 05	0.11700000E 05
0.15800000E 05	0.15600000E 05
0.39600000E 00	0.42041957E 00
-0.82055433E-03	-0.85407309E-03
-0.20642947E-05	-0.20510815E-05
0.16056295E-10	0.15222337E-10
-0.26935136E 03	-0.26509839E 03
-0.34117918E-01	-0.34522444E-01
0.47504645E-05	0.44801745E-05
0.38675019E-09	0.39979131E-09
-0.30364990E 03	-0.30666992E 03
0.48963636E-01	0.32865789E-01
-0.16947088E-03	-0.21991495E-04
0.82826842E-06	0.27331424E-06

EIGHTH BALLISTIC TABLE

0.50000000E 01	0.30000000E 02	0.55000000E 02
0.20000000E 01	0.20000000E 01	0.20000000E 01
0.0	0.0	0.0
0.12600000E 05	0.12700000E 05	0.11900000E 05
0.78984350E-02	0.60268939E-02	0.43568313E-02
-0.94776651E-05	-0.68760019E-05	-0.50171911E-05
0.16801243E-08	0.98311603E-09	0.59067928E-09
-0.19521174E-12	-0.14947207E-12	-0.13104155E-12
-0.23902911E 00	-0.23778242E 00	-0.20235212E 00
-0.20282694E-03	-0.17015025E-03	-0.12539959E-03
0.14314381E-07	0.64431980E-08	0.60069745E-08
-0.42029764E-12	0.15314260E-11	0.34577972E-12

EIGHTH BALLISTIC TABLE

```

0.80000000E 02
0.20000000E 01
0.0
0.11300000E 05
0.29051665E-02
-0.32701882E-05
0.20453642E-09
-0.11043857E-12
-0.16830163E-00
-0.11204566E-03
0.84507223E-08
-0.96344634E-12

```

NINTH BALLISTIC TABLE

0.50CCCC000E 01	0.30C000000E 02	C.55CCCCCCE 02
0.2CCCCC00E 01	0.20000000E 01	0.200CCCCCE 01
0.C	0.0	C.0
0.12C000000E 05	0.12000000E 05	C.135CCCCCE 05
C.1CCCC5646E 01	0.99729544E 00	0.980CC503E 00
0.39535269E-04	0.5C992487E-04	0.78381025F-04
0.15712018E-08	-0.69385650E-10	-0.59941350E-08
0.23104836E-13	0.18110844E-12	0.64646118E-12
0.17551136E 01	0.18885870E 01	0.243925CCE 01
0.974C1966E-04	0.22189190E-03	0.110320CCE-02
-0.13142813E-07	-0.44501011E-07	+0.83042806E-06
0.60034481E-12	0.74270624E-11	0.28619240E-09
0.C	0.0	0.0
C.C	0.0	0.0
0.0	0.0	0.0
C.C	0.0	0.0
0.0	0.0	0.0

NINTH BALLISTIC TABLE

```

0.80000000E 02
0.30000000E 01
C.C
0.12000000E 05
0.15200000E 05
C.98125558E 00
0.79034871E-04
+0.61084568E-03
0.74429899E-12
0.23181391E 01
0.58374787E-03
-0.27691374E-06
0.11478704E-09
0.51725157E 01
0.57250932E-02
-0.14298257E-04
0.35073608E-07

```


TENTH BALLISTIC TABLE

0.0	0.30000000E 02	0.80000000E 02
0.10000000E 01	0.10000000E 01	0.10000000E 01
0.0	0.0	0.0
0.84499997E 00	0.88299996E 00	0.94699997E 00
0.0	0.0	0.0
0.10000000E 01	0.99040598E 00	0.97441596E 00
0.0	0.51994499E -06	0.13866511E -05
0.10015929E 00	0.10010748E 01	0.10000000E 01
-0.10728629E -04	-0.72468247E -05	0.0

ELEVENTH BALLISTIC TABLE

0.50000000E 01	0.20000000E 02	0.40000000E 02
0.20000000E 01	0.20000000E 01	0.30000000E 01
0.0	0.0	0.0
0.15000000E 05	0.15000000E 05	0.14000000E 05
0.44295695E-01	0.39856613E-01	0.16500000E 05
0.11021075E-05	0.13935942E-05	0.30672155E-01
0.61905224E-01	0.61612882E-01	0.14965781E-05
0.20288544E-05	0.32180051E-05	0.51941060E-01
0.0	0.0	0.42543634E-05
0.0	0.0	0.62320661E-01
0.0	0.0	0.74444060E-05

ELEVENTH BALLISTIC TABLE

C.6CCCC00COE 02	0.800000000E 02
C.3CCCC00COE 01	0.300000000E 01
0.0	0.0
C.14CCCC000E 05	0.140000000E 05
C.16CCCC000E 05	0.156000000E 05
C.17343938E-01	0.51356144E-02
0.13595636E-05	0.58914418E-06
C.26460474E-01	0.13199501E-01
0.54652728E-05	0.35339954E-05
0.48195675E-01	0.19671310E-01
0.15476704E-04	0.15286496E-04

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13. ABSTRACT			
The GFCS MK86 solves the ballistics problem for the 5"/54 gun iteratively utilizing table look-ups. Each ballistics parameter table is sub-divided two-dimensionally, corresponding to selected elevation and slant range intervals. The final value for each parameter is found by interpolating between parameter values evaluated at elevation angles which bracket the actual elevation angle. This thesis describes the method of determining the ballistics solution for AA cartesian ballistics. A description of the ballistics geometry and of the model utilized is presented, together with a FORTRAN simulation of the MK86 computer program and a listing of the ballistics tables used in this system.			

KEY WORDS

LINK A

LINK B

LINK C

ROLE

WT

ROLE

WT

ROLE

WT

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Ballistics

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